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What Drives Wind and Solar Energy Investment in India and China?

Stephen Spratt, Wenjuan Dong, Chetan Krishna, Ambuj Sagar and Qi Ye

July 2014

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Abbreviations and acronyms

AD	accelerated depreciation
BIPV	building integrated photovoltaics
CASE	Committee on Alternative Sources of Energy (India)
CDB	China Development Bank
CDM	Clean Development Mechanism
CERC	Central Electricity Regulatory Commission (India)
c-Si	crystalline silicon
EDAs	Energy Development Agencies (India)
Exim	export-import
FCCBs	Foreign Currency Convertible Bonds
FiT	feed-in-tariff
GBI	generation-based incentive
GDP	gross domestic product
GW	gigawatt
ICBC	Industrial & Commercial Bank of China
IEA	International Energy Agency
IPP	independent power producer
IREDA	Indian Renewable Energy Development Agency
IRR	internal rate of return
kt	kilotonne
kW	kilowatt
kWh	kilowatt hours
LSE	London Stock Exchange
MBPV	Moser Baer Photovoltaics
MNRE	Ministry of New and Renewable Energy (India)
MoF	Ministry of Finance
MoP	Ministry of Power (India)
MW	megawatt
NAPCC	National Action Plan on Climate Change (India)
NDRC	National Development and Reform Commission (China)
NEA	National Energy Administration (China)
NEC	National Energy Commission (China)
NPC	National People's Congress (China)
NSM	Jawaharlal Nehru National Solar Mission
NYSE	New York Stock Exchange
PE/VC	private equity/venture capital
PPA	power purchase agreement
PSA	power supply agreement
PV	photovoltaic
R&D	research and development
REC	renewable energy certificate
RPO	renewable purchase obligation
SASAC	State-owned Assets Supervision and Administration Commission (China)
SDC	small distributed capacity
SEBs	state electricity boards (India)
SERC	State Electricity Regulatory Commissions (India)
SETC	State Economic and Trade Commission (China)
SOEs	state-owned enterprises (China)
TNEB	Tamil Nadu Electricity Board
TNERC	Tamil Nadu Electricity Regulatory Commission
TUFS	Textile Upgradation Fund Scheme (India)
UNFCCC	United Nations Framework Convention on Climate Change
XWE	Xinjiang Wind Energy Ltd

1 Introduction

This research is motivated by the need to transform the basis of energy systems from fossil fuels to renewable sources. As well as the imperative of climate change, this transformation is needed to create development trajectories for economies that are genuinely sustainable over the long term. Our objectives are therefore both environmental and developmental.

Understanding what drove low-carbon investments in the past is the key to identifying the drivers of investment in the future. In this regard, low-carbon investment decisions are not technical questions of optimal asset allocation. Rather, understanding these decisions requires an approach rooted in political economy, which assesses the motivations and incentives of the different actors involved, and how these interact. Understanding the dynamics of this process is the first step in shaping it.

This research concentrates on private investment. Of the US\$45 trillion of investments that the International Energy Agency (IEA) estimates are required by 2050 to reduce global carbon emissions by half, it is assumed that 85 per cent will need to come from the private sector. Annually, this averages at a little over US\$1 trillion, half of which will fund the replacement of existing technologies, largely in developed countries. The remaining US\$530bn is investment in new capacity, the bulk of which (US\$400bn pa) will be in developing countries (IEA 2008).

Our focus is on the determinants of low-carbon investment in the world's two largest emerging economies: China and India. While these countries are responsible for the biggest growth in carbon emissions, China is now the largest global investor in renewable energy and India saw the highest growth rate in recent times between 2010 and 2011 (BNEF 2012). While China has maintained its leading position, renewable energy investment in India fell by 50 per cent between 2011 and 2012, from a little under US\$13bn to US\$6.1bn (BNEF 2013). Although 2013 saw a marginal increase in investment, the importance of India with respect to global carbon emissions makes understanding this reversal very important.

As well as direct impacts, what happens in China and India matters indirectly because of the example their models of development provide. That said, the fact that our research concentrates on India and China should not detract from the need for a rapid acceleration of progress in developed economies. Both historical responsibilities for causing climate change and the scale of current greenhouse gas emissions demand that developed countries are at the forefront of a transition to sustainable energy systems. But progress has stalled in Europe, and the US is in the grip of a very different type of energy 'revolution'. Given this, it may now be time to look elsewhere for solutions.

We also focus on wind and solar energy: these have been by far the most important renewable technologies, and will continue to be so. In 2012, China invested a total of US\$59.1bn in renewable energy, 47 per cent in wind and 44 per cent in solar. Of the US\$6.1bn that India invested in 2012, 50 per cent was in wind and 30 per cent in solar. While Indian investment rose to US\$7.8bn in 2013 it is still far short of the 2011 peak. Renewable energy investment in China fell by 3.8 per cent in 2013, its first reduction in a decade. Reversing a decade of steady annual rises, 2013 and 2012 saw global renewable energy fall by 9 and 12 per cent respectively.

To reverse these trends, we need to understand what drives renewable energy investment in different countries, and to design interventions to affect these drivers. It is also important to consider how these national-level forces combine to create a global picture: mitigating climate change, ultimately, requires a global perspective, albeit one constructed from national building blocks. Although we focus on India and China, therefore, the approach

developed here could be applied to any country. It is hoped that this research will provide a platform upon which future work can build.

The rest of the paper is structured as follows. Section 1 describes our research questions and the conceptual framework employed. Section 2 gives background on the Indian and Chinese contexts. Section 3 provides a comparative synthesis of the Indian and Chinese case studies. Section 4 distils the key findings, while Section 5 looks at policy implications.

2 Research questions and conceptual framework

The primary question motivating this research was: What are the primary drivers of investment in wind and solar energy in India and China?

While the primary driver of all investment is a perceived business opportunity, renewable energy investments differ in important ways. Most pertinently, unlike in many other sectors, business opportunities often arise because government provides financial incentives – i.e. creates ‘policy rents’.¹ While crucial, this explanation is not sufficient to explain the level and pattern of investment we observe. Despite the failure to implement a significant global carbon price, for example, global investment in renewable energy grew more than six-fold in as many years, from US\$35bn in 2004 to US\$237bn in 2011. Very different rates of renewable energy investments, both between countries and within the same countries over time, cannot be entirely explained by movements in policy rents.

Markets and governments do not operate in a vacuum but in specific political contexts. An emerging literature investigates these political contexts and cuts through complexity by focusing on how alignments of interest between different actors can influence behaviour, leading to changes in government policy or in market activity. In some cases, such alignments arise naturally (they are ‘incidental’ or ‘uncoordinated’). In others, they are forged consciously, or ‘engineered’. Where alliances are forged consciously, one can talk of alliances of actors that promote or block a particular cause. This study is particularly interested in the role of such alignments or alliances in shaping wind and solar energy investment in China and India. The expectation is that this focus might help us to understand not only investment but also how such investment is influenced politically.

While relatively new to the subject of renewable energy investment, the ‘alliance’ or ‘coalition’ perspective has been applied to other aspects of political or economic reform. At the most general level, such groupings can be described as:

...individuals or groups that come together, formally or informally, to achieve goals they could not achieve on their own. Whether focussed on minor but locally important reforms; whether campaigning for the creation or abolition of a law; whether driving through major social or economic institutional or policy change; whether bringing together a series of diverse interests or groups around a common program of action; whether harnessing public and private collaboration between actors, departments or organizations – ‘coalitions’ are part and parcel of everyday politics, everywhere, nationally and sub-nationally and in all sectors and issue areas.
(Developmental Leadership Program 2012: 3)

This perspective has been applied to ‘reform coalitions’ that come together to achieve a particular political or economic reform (Peiffer 2012), and to ‘growth alliances’, where informal alliances between policymakers (public sector) and investors (private sector) were found to be important drivers of investment in Egypt (Abdel-Latif and Schmitz 2010).

Central to the ‘alignment of interest’ approach is that different actors need not have shared motivations to be effective, but rather need to have sufficiently common interests or objectives. Emerging research suggests that this has been an important factor in Europe. In Denmark, for example, experimentation with wind energy received substantial support from politicians and business leaders concerned with energy security in the wake of various oil

¹ See Schmitz, Johnson and Altenburg (2013) for an overview of the use and management of policy rents.

crises. While actors motivated by environmental concerns played an important role, this was insufficient until they were joined by others motivated by the chance to build a globally competitive industry and generate 'green jobs' (Schmitz 2014, forthcoming).

The relevance of alliances to our case study countries is supported by recent research on the local politics of climate change in China and India:

In both countries the ability to build and sustain coalitions is central to the effectiveness and sustainability of climate change policy. For various reasons, state strategies in China and India have focused on the need to bring different parties with otherwise divergent interests on board to build a coalition in favour of climate mitigation measures.
(Harrison and Kostka 2012: 5)

To explore the light this framework can shed on our primary research question, and to consider the implications this has for policymakers concerned with accelerating these kinds of investment, the country case studies addressed the following sub-questions:

1. Looking at important events and periods with respect to wind and solar energy investment, which actors were the most important in initiating and shaping these events?
2. What were the primary goals of these actors, and to what extent were they aligned?
3. To what extent, and in what ways, can these groups be described as alliances?
4. For those concerned with accelerating renewable energy investment, what lessons can be learned about the roles that alliances could play in this process?

The first methodological step in addressing these questions is to decide what constitutes a 'pivotal event'. On this question, we can distinguish between three broad types of event: first, the emergence of private companies in the wind and solar sectors that would become significant players – these may be manufacturers, wind or solar facility developers, or both; second, periods of significant investment in the productive capacity of the manufacturing sector; third, periods of significant investment in installed wind or solar generation capacity.²

Having chosen periods or particular events of interest, the research proceeded in two stages. First, a desk-based review of existing sources developed a detailed chronology of events, identified the key actors involved, and developed hypotheses about the nature and role of potential alliances in shaping these events. Second, these hypotheses were tested in a series of semi-structured interviews with relevant actors.

Before examining these studies in detail, the next section provides essential background information for China and India.

² The Bloomberg New Energy Finance database was used to analyse patterns of investment.

3 The Chinese and Indian contexts

3.1 Some basics

As shown in Table 3.1, the Chinese economy is almost four times larger than that of India, with a similar difference in average annual income. This is broadly reflected in total and per capita CO₂ emissions. At 99.7 per cent, access to electricity is much higher in China than in India (75 per cent). For sources of electricity, we see a similar dominance of coal, which accounts for 78.9 per cent of all electricity generated in China and 67.9 per cent in India. Despite the fact that China has invested far more significantly in renewables over the past decade than India has, the actual proportion of total electricity generated from renewable sources (excluding hydroelectric power) is just 2.2 per cent of the total, compared with 5 per cent in India.

Table 3.1 Comparative income and energy statistics

	China	India
GDP (US\$ billions)	7,321.90	1,872.80
GDP per capita (US\$)	5,447.30	1,533.60
Access to electricity (% of population)	99.7	75
CO ₂ emissions 1,000kt	8,286.90	2,008.80
CO ₂ emissions (metric tons per capita)	6.2	1.7
Electricity from coal (% of total)	78.9	67.9
Electricity from renewables (excluding hydro % of total)*	2.2	5
Total installed electricity generation capacity (GW)	1,100	238

Sources: Adapted from World Bank (2013); US Energy Information Administration (EIA) (2013).

* Proportion of energy from hydroelectric sources: China (14.8%); India (12.4%).

Although installed wind and solar capacity is a small proportion of total energy production, there is considerable potential. Onshore wind capacity has been estimated at 250GW for China (World Energy Council 2007), and 103GW for India (Ministry of New and Renewable Energy 2013). As we can see from Table 3.1, this is about a quarter of China's total energy capacity, and a bit less than half of India's. While national estimates are not currently available for India,³ offshore potential in China has been estimated at 750GW, suggesting that fully exploiting China's on- and offshore wind potential could yield the equivalent to the country's current total capacity (World Energy Council 2007).

The potential of solar is even greater. In its 2007 survey of potential energy resources, the World Energy Council describes the potential in China as follows:

It is estimated that two-thirds of the country receives solar radiation energy in excess of 4.6 kWh/m²/day, with the western provinces particularly well endowed. China's annual solar power potential has been estimated to be 1 680 billion toe [tonne of oil equivalent] or 19 536 000 TWh. Capturing 1% of this resource, and utilising it with 15% efficiency, could supply as much electricity as the whole world presently consumes in eighteen months.
(World Energy Council 2007: 402)

With solar resources ranging between 4 and 7kWh/m² depending on location, and an average of 300 days of sunshine per year, the potential in India is on a similarly vast scale.

³ For Tamil Nadu alone, however, offshore wind potential has been estimated at 127GW (Ministry of New and Renewable Energy 2013).

3.2 General political arrangements and responsibilities

India is a federated union of 28 states and seven union territories, with an executive, judiciary and legislature at each level. Legislative powers are split between central and state government in different ways, depending on the issue. The governance of land and waterways falls under the jurisdiction of the state, for example, while central government is responsible for forests and ecosystems. Divisions of responsibility are not always clear, however, as laws can be passed at both state and federal level in some areas. Electricity is one such example. While the taxation, sale and local governance of power is the responsibility of the state, the central government is responsible for interstate integration and the national power market. These responsibilities are complemented by other federal agencies such as the Planning Commission, which reviews economic sectors from a macro-economic standpoint, formulates policy and provides guidelines to various actors (including at state level). As in most countries, the Ministry of Finance (MOF) is a powerful actor.

Governance arrangements and responsibilities in China are also divided between central and local government. As well as its 22 provinces, China has four municipalities (the four most important cities in China), five autonomous regions and two special administrative regions. Central government provides general guidelines on economic policy, land use and political matters; can alter the geographic boundaries of localities; appoint or remove local officials; and can reallocate funds between provinces (Cheung 2009). Local governments are responsible for the economic development of their areas, and have the right to make decisions on the specific uses of land. Although they have considerable autonomy, local officials are evaluated on their performance in generating economic development, which determines promotion prospects. They are also subject to direct influence from central government and top officials (Ma 2012).

3.3 The energy (and renewable energy) sectors: evolution of governance arrangements

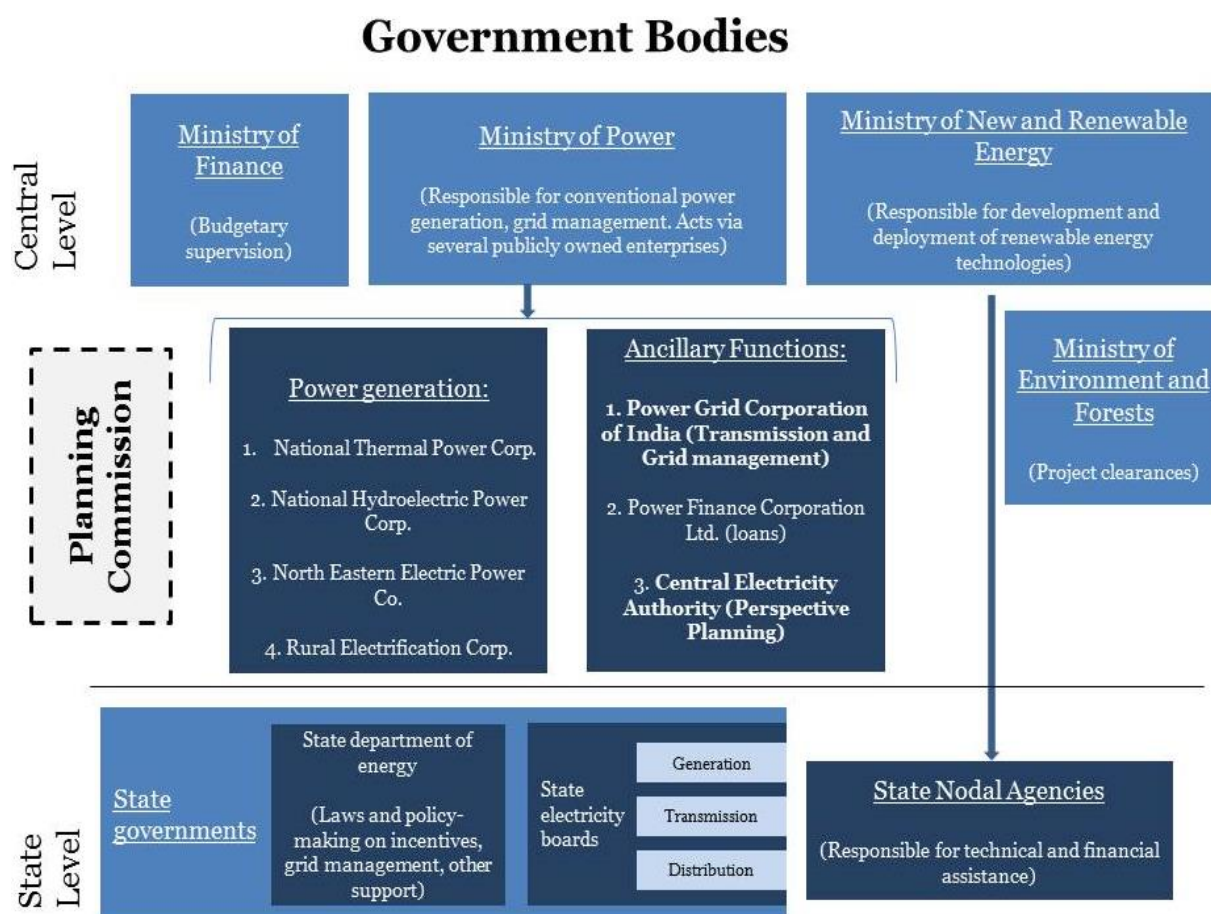
3.3.1 India

At federal level in India, the Ministry of Power (MoP) is responsible for thermal and (large) hydroelectric power generation, transmission and distribution, and for maintaining the national grid infrastructure. In practice, the MoP operates through 'public sector undertakings'. Despite some deregulation since the 1990s, the MoP and state government-owned firms continue to hold monopolies in generation, distribution and transmission. In 2010, for example, 82 per cent of power generated was by state-owned firms (Krishna, Sagar and Spratt 2014, forthcoming).

Each state typically has a local grid connected to the larger regional grid maintained by state-owned utilities, though these are of inferior quality compared to the national grid. At state level, 'state electricity boards' carry out power generation, transmission and distribution in parallel with the activities of the MoP.

The electricity market in India is highly illiquid. Almost 90 per cent of power is sold under long-term contracts of up to 25 years, i.e. 'power purchase agreements' (PPAs) and 'power supply agreements' (PSAs). Intra-day trading accounts for less than 3 per cent of total power, with 6 per cent of power traded over a period of three months to three years. This pattern also holds for renewable energy. Figure 3.1 illustrates governance arrangements in the India power sector.

Figure 3.1 Governance arrangements in the India power sector



Source: Krishna *et al.* (2014, forthcoming).

The aim of a series of electricity reforms begun in the late 1990s was to liberalise the sector, encourage competition, attract investment and ensure greater transparency. (It should be noted that many recommendations have yet to be fully implemented in various states.) A two-tiered system of regulation to oversee state electricity boards (SEBs) was also established. Within this framework, the Central Electricity Regulatory Commission (CERC) and State Electricity Regulatory Commissions (SERC) have become very important for the power sector in general and the renewable energy sector in particular. Together, they are responsible for:

- tariff regulation (prices paid both by consumers and to producers);
- management of grid infrastructure (in conjunction with SEBs);
- promotion of environmentally sustainable policies and alternative forms of energy;
- dispute resolution between stakeholders;
- licensing and interstate operations;
- national tariff policy and electricity policies;
- recommendations for the development of the electricity market.

Until 1993, most state electricity boards were running year-on-year losses, which subsidies by the state and federal governments were not enough to cover. With mounting losses, their capacity to invest in infrastructure and generating capacity was eroded, and their institutional effectiveness gradually declined. A large part of the explanation was that SEBs were required to subsidise some parts of the market (notably agriculture). Industrial consumers were charged extremely high rates to make up for the losses (see Tongia 2003). Faced with high prices and unreliable supply, industrial consumers increasingly generated their own power, and/or bought power on the open market rather than from state utilities.

In conjunction with the World Bank, a series of far-reaching reforms of SEBs was designed, which entailed the 'unbundling' of activities and creation of separate institutions, in a privatised form where appropriate. Some states adopted reforms early (e.g. Orissa, Uttar Pradesh and Delhi), while many resisted (Tamil Nadu only began its unbundling in the late 2000s and Maharashtra in 2005). Even where unbundling has taken place, most SEBs are structured as one holding company and several subsidiaries rather than as genuinely separate entities. Many utilities continue to run deficits.

In response to the oil shocks of the 1970s, the Indian Committee on Alternative Sources of Energy (CASE) was established in the 1980s, with a remit to develop and deploy new technologies to harness nonconventional energy. In 1996, this became the Ministry of New and Renewable Energy (MNRE). As well as these inherited responsibilities, the MNRE was mandated to work with other ministries to extend subsidies and tax breaks and to develop other provisions for renewable energy. At state level, Energy Development Agencies (EDAs) provide technical assistance for renewable energy policy design and disburse federal funds as renewable energy incentives.

Developing out of the Prime Minister's Office, the National Action Plan on Climate Change (NAPCC) and the National Solar Mission (NSM) were both launched in 2008.

3.3.2 China

Renewable energy has long been part of China's development strategy. In 2001, China's 10th Five-Year Plan stated that:

The development and utilization of new energy and renewable energy is one of the key strategic measures to upgrade China's energy mix, to improve environment and to promote sustainable economic and social developments.
(Xinhua Net 2001)

The Renewable Energy Law of 2005 identified renewable energy development as a 'national strategy' – highly significant in a Chinese context. In 2010, under the 'Decision of the State Council on Accelerating the Cultivation and Development of Strategically Important New Industries', the new energy industry was listed as one of seven strategic emerging industries with various supporting structures, including accessing finance from China's state-owned banks.

The key actors in the energy policymaking processes at the highest level in China are the National People's Congress (NPC) and the State Council. The NPC is the country's most important legislative body, while the State Council is the leading administrative unit responsible for implementing the laws and policies of the NPC.

Under the State Council, there are a number of major institutions with influence over, and responsibility for, China's energy policies. The National Energy Commission (NEC), National Development and Reform Commission (NDRC), National Energy Administration (NEA) and State-owned Assets Supervision and Administration Commission (SASAC) are the most important central government actors that influence energy (and renewable energy) policy and practice.

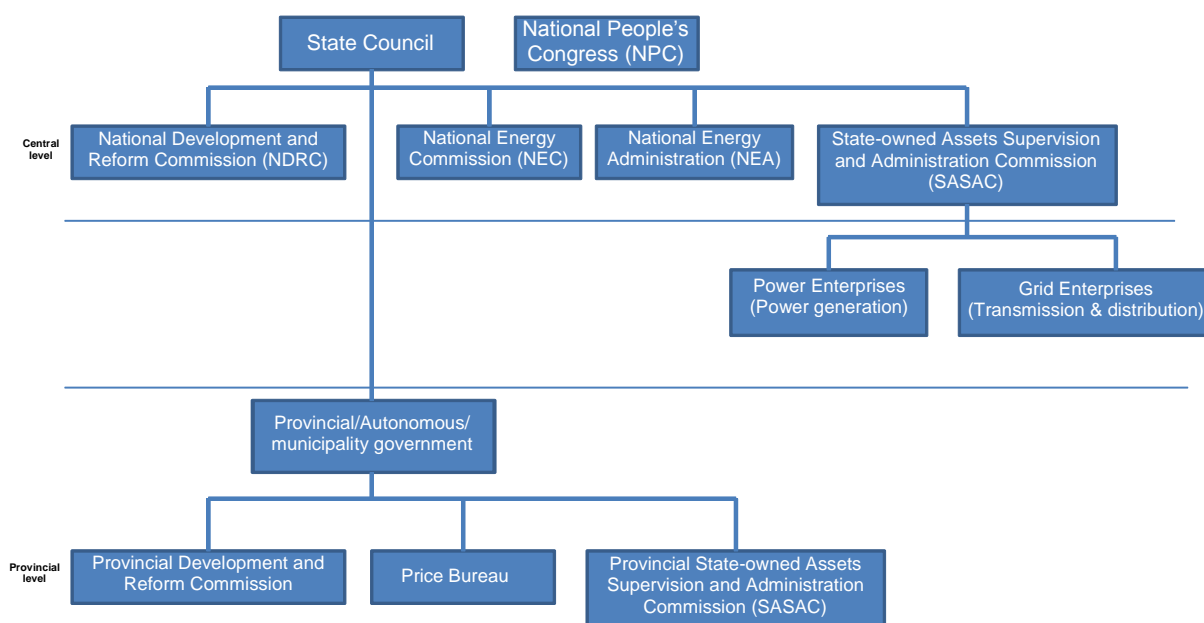
The NEC is a high-level discussion body (or thinktank) with ministerial rank and responsibility for coordinating overall energy policies. It produces the country's energy development strategy and monitors its implementation. The NDRC is a macroeconomic management agency operating under the State Council; it formulates economic and social policy, and guides the trajectory of economic development. The NDRC is important in the energy industry, as it approves major energy projects and controls pricing. The NEA manages

energy industries, drafts energy plans and policies, deals with international bodies and approves foreign energy investments.

Operating directly under the State Council, the SASAC is the representative of the government in state-owned enterprises (SOEs). Sector reforms in 2002 resulted in the formation of two state-owned grid companies and five state-owned power generation companies, commonly known as the 'Big Five'.⁴ Together these comprise the State Power Corporation of China. The two grid companies are the State Grid and the China Southern Power Grid (Tsang and Kolk 2010).

Figure 3.2 illustrates governance arrangements in the China power sector.

Figure 3.2 Governance arrangements in the China power sector



Source: Adapted from Tsang and Kolk (2010).

The State Council has undertaken periodic restructuring of relevant institutions. The Ministry of Energy was dissolved in 1993. From 1993 to 2003, the NDRC and the State Economic and Trade Commission (SETC) were the two key policymaking institutions for energy development. In 2003, the SETC was dissolved and the Bureau of Energy formed within the NDRC. In 2008, the Bureau was reorganised as the NEA. In 2010, the National Energy Commission (NEC) was established as the highest-level agency to coordinate overall energy policies (Liu 2013).

⁴ The five are: China Guodian Corporation, China Huaneng Group, China Datang Corporation, Huadian Corporation and China Power Investment Corporation.

3.4 The evolution of policy

Table 3.2 Policy chronology

	Lead Institution	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013		
China	Other								Provincial FiT issued in Jiangsu province					
	State Council						Mid- and Long-Term Development Plan for Renewable Energy (10% target)							
									7 ‘Strategically Important Industries’ announced					
	SERC						Grid companies obliged to purchase renewable energy							
	MoF					Renewable Energy Development Fund								
	NDRC					Interim Measures on Renewable Generation Tariff and Cost Sharing Management								
							Fifth wind concession tender (average rather than lowest cost)							
									4 different FiTs set for onshore wind					
									National solar FiT introduced					
	NPC	REL developed												
					Renewable Energy Law (REL) passed									
NEA									Tentative Measures for Offshore Wind					
									First concession tender for offshore wind					
									Annual Wind Approval Management					
India	MoP	7th National Five Year Plan (1985) allows ‘wheeling’, ‘banking’ and ‘third-party sales’ in energy sector												
		Electricity Act												
					National Electrical Policy									
						National Tariff Policy								
									Renewable Energy Certificates (RECs)					
	Planning Commission				Integrated Energy Policy									
	MNRE							Jawaharlal Nehru National Solar Mission (NSM)						
								Generation-based Incentive (GBI) (wind)						
	MoF	Accelerated depreciation (AD)									35% AD			
ERCs					Renewable Purchase Obligations (RPOs)									
Other								Gujarat Solar Policy						

3.4.1 Wind and solar investment landscapes

Wind and solar energy accounted for 37 per cent and 42 per cent respectively of global investment in renewables between 2004 and 2012. Up until 2010, wind investment was the larger of the two, but has since been overtaken by solar. By 2012, 33 per cent of global renewable energy investment was in wind, compared with 57 per cent in solar. Of the different forms of financing for these sectors, the four most important are:

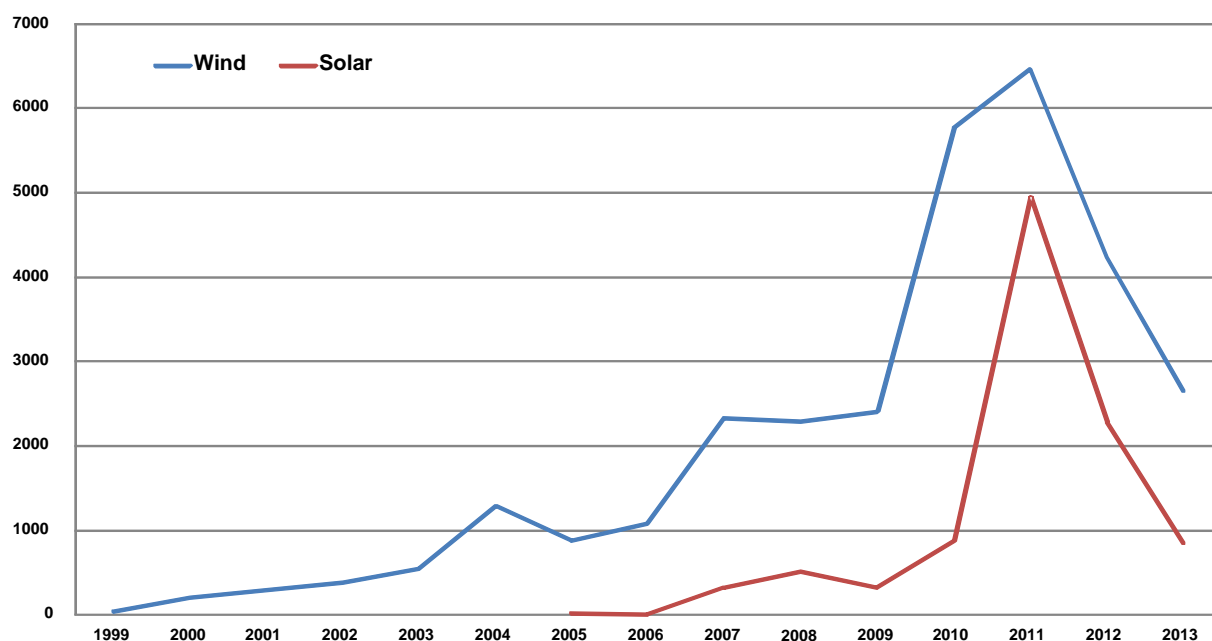
1. **Asset finance**, where loans are provided on the basis of a project's prospective returns (i.e. against the project's balance sheet) and secured against the project's assets. Commercial and national or multilateral development banks (generally a group, or 'syndicate') are the principal providers. Equity investors are also important, with an average 70/30 debt-to-equity ratio.
2. **Small distributed capacity (SDC)**, which describes residential and small-scale commercial installation – generally solar panels – for own supply, with surplus supply feeding into the grid. Finance is supplied by households or firms. A variant is 'captive power', where an industrial company develops its own energy generation capacity.
3. **Public equity markets**, where finance is raised through the flotation of a firm on the primary market (i.e. an initial public offering), or the issuance of additional shares ('secondary share issue') by a firm that is already listed. Finance is supplied by a range of investors.
4. **Private equity/venture capital (PE/VC) funds**, which invest in companies at an early stage. Generally VC funds provide start-up finance, while PE funds provide capital for expansion, often with a view of 'exiting' the investment through an initial public offering (IPO) on a public equity market.

Of these, asset finance is by far the most common, accounting for 64 per cent of global investment between 2004 and 2012. The corresponding figures for SDC, public equity and PE/VC are 22 per cent, 6 per cent and 3 per cent respectively (BNEF 2013). While asset finance has been consistently the most common form of finance, the importance of other forms has varied significantly. Reflecting buoyant equity market conditions before the global financial crisis of 2008, public equity markets accounted for 15 per cent of global investment in 2007; by 2012, this was 1.6 per cent. The importance of SDC has also fluctuated, falling from 22 per cent of the total in 2004 to less than 10 per cent in 2007, before rising again to 32 per cent by 2012. PE/VC funds have always been relatively small, with their share of global investment ranging from a peak of 5.8 per cent in 2008 to a trough of 1.6 per cent in 2012. These global averages mask significant regional variations. In the US, for example, PE/VC funds play a much larger role than elsewhere, while in Europe there is a disproportionately high level of SDC financing.

Figure 3.3 illustrates wind and solar energy investment in India since 1999. Wind is the largest sector throughout the period, with solar investment only starting in 2005, and only becoming significant after 2009. For wind, we see a steady increase from 2000 onwards and a sharp spike in 2009. Both types of investment peaked in 2011 when a little under US\$6.5bn and US\$5bn were invested in wind and solar respectively. Since that time there has been a sharp fall in investment in both sectors.

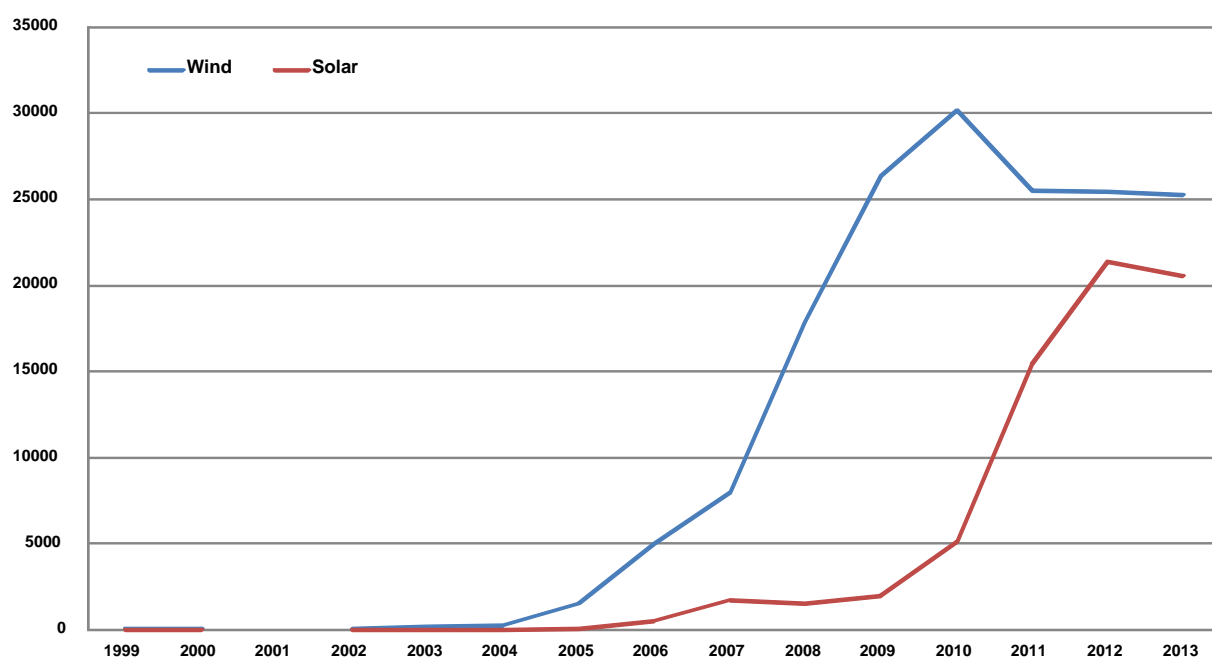
Figure 3.4 gives the same information for China. As with India, wind investment is greater than solar in every year, and solar investment does not increase rapidly until recent years. After rising sharply from 2007, wind investment peaks in 2010, with more than US\$30bn invested. The largest solar investment is in 2012, when slightly under US\$22bn is invested. Unlike India, these peaks were not followed by precipitous falls, with investment remaining high.

Figure 3.3 Wind and solar investment in India, 1999–2013 (US\$m)



Source: BNEF (2013).

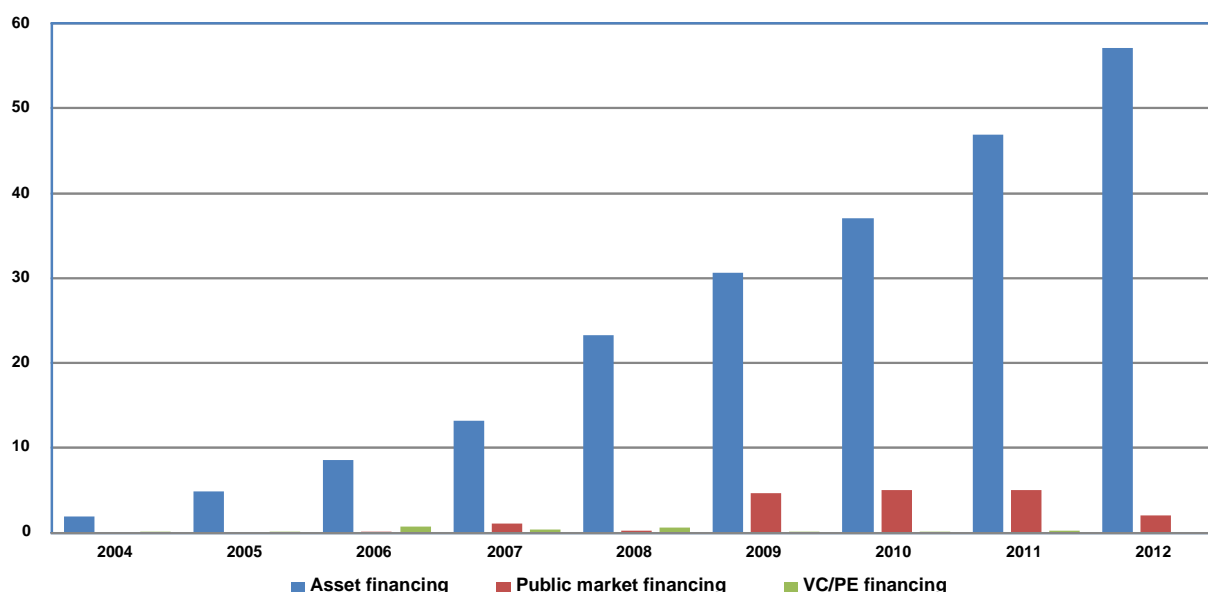
Figure 3.4 Wind and solar investment in China, 1999–2013 (US\$m)



Source: BNEF (2013).

The following two charts depict the financing mix for both countries. In line with the global picture, Figure 3.5 shows that asset finance is by far the most important form of financing in China.

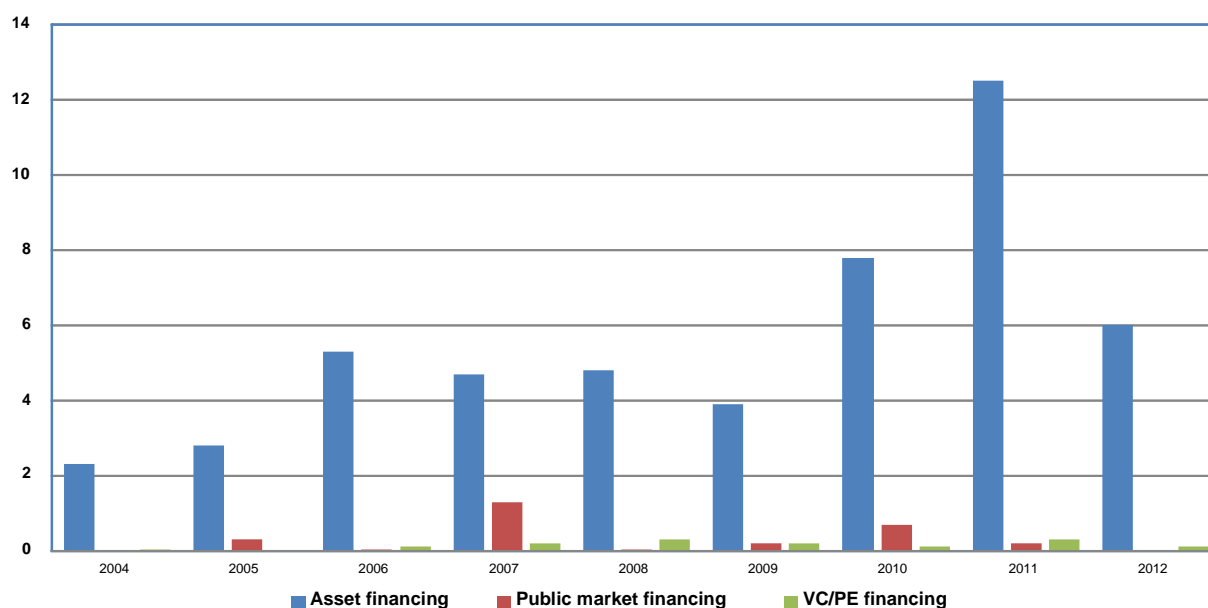
Figure 3.5 China's renewable financing mix, 2004–2012 (US\$m)



Source: BNEF (2013).

While PE/VC activity in China has remained minimal, financing from public equity markets has become more important since 2009.

Figure 3.6 India's renewable financing mix, 2004–2012 (US\$m)



Source: BNEF (2013).

Asset finance is similarly dominant in India, as shown in Figure 3.6. The most important differences from China are: scale (investment in China is ten times greater at some points); volatility (rather than the steady growth in China, investment in India is more unpredictable); and diversity (although asset finance is dominant, there is relatively more PE/VC activity, and public market financing is important in some years). On this last point, it is interesting to note that public equity markets were the source of more than 20 per cent of investment in India's renewable energy sector in 2007 – a time of pre-crisis 'exuberance' in global stock markets.

Before delving more deeply into these trends through the country-level case studies, the next sections provide an overview of the wind and solar sectors in India and China.

3.5 Overview of the wind sectors in India and China

3.5.1 The wind sector in India

In its early days, the MNRE (then CASE) focused on wind power. In 1989 the first wind turbine demonstration project was launched in Gujarat,⁵ in conjunction with the Gujarat Electricity Board and the Danish International Development Agency. This was followed by the launch of the Indian Renewable Energy Development Agency (IREDA), using seed funding from the World Bank, to provide finance for renewable energy projects.

Early projects targeted industrialists who were interested in wind energy as an alternative to erratic and costly power from the state electricity boards (SEBs).⁶ Since then, the wind industry has gone through four phases. The first (1990–2000) focused on learning and the adaptation of foreign technology to Indian conditions. There was also consolidation in the manufacturing sector and the development of policy instruments to encourage the growth of domestic industry (Mizuno 2007).

In the second phase (2000–7) policies to support wind power took shape in the context of wider power sector reform. The third phase (2007–9) saw the rapid investment growth shown in Figure 3.3 occurring under a relatively stable policy regime. The final phase (2009 to the present) saw a maturing of business models with a focus on power generation (as opposed to installed capacity) in the first half of this period. Since 2011, a sharp fall in investment has occurred.

Table 3.3 Wind facility construction by size and period

MW	2003–6	2007–9	2010–13	Total
<5	51	152	461	664
5 to 10	48	64	103	215
10 to 20	38	61	67	166
20 to 40	23	39	55	117
40 to 60	6	13	47	66
60 to 100	4	8	16	28
100+	3	2	25	30
Total	173	339	774	1,286

Source: Krishna *et al.* (2014, forthcoming).

Geographically, the wind sector in India is concentrated in a few states with rich wind resources, namely: Karnataka, Tamil Nadu (which has the best-quality resource), Maharashtra, Gujarat, Rajasthan and Andhra Pradesh.

Table 3.3 gives a breakdown of the number of wind generation facilities built of different sizes, ranging from less than 5MW to large facilities capable of generating more than 100MW. Very small facilities are most common in each period.

Projects in the 5–20MW range are typically undertaken by private sector firms, with other core businesses diversifying into the wind sector. Larger projects of 20 to 40MW have a mix of investors, including larger power companies, diversified firms, independent power producers (IPPs) and publicly owned utilities; and 40–100MW projects are owned by large conglomerates, IPPs or publicly owned firms only. Large-scale facilities (>100MW) have become more common in the most recent period. This is the result of the emergence of large IPPs backed by international financial investors.

⁵ After Tamil Nadu, Gujarat has the best wind energy potential in India.

⁶ See Rajsekhar, van Hulle and Jansen (1999) for details.

Business models in the wind sector have evolved considerably. Prior to 2003, '**captive power**', where manufacturing companies built their own wind generation facilities, was the dominant form. As well as the 'push factors' of expensive and unreliable energy, SEBs purchased surplus energy and supplied valuable 'wheeling' and 'banking' facilities. 'Wheeling' enabled power producers to transfer surplus energy to industrial users in other parts of the state, while 'banking' enabled them to 'bank' surplus energy and draw it down later. In combination with low-cost debt from IREDA, and the 100 per cent 'accelerated depreciation' that was permitted, these features generated an average internal rate of return (IRR) of 10 per cent (Krishna *et al.* 2014, forthcoming).

The captive power model continued from 2003 to 2009, with some slightly different features. Permitted accelerated depreciation fell from 100 per cent to 80 per cent, but developers could take advantage of tax holidays, as well as obtain finance from the Clean Development Mechanism (CDM). The net result was an increase in average project IRRs to 12 per cent. A second business model that emerged in this period was the '**turnkey**' **wind park**, supplying state utilities with energy on 10–25-year contracts. Projects were developed 'end-to-end' by wind turbine manufacturers. As well as tax and CDM advantages and debt financing from IREDA, developers received premium rates via state feed-in tariff. These features boosted average returns to 14–16 per cent.

A third business model that emerged during this period comprised projects to sell '**merchant power**' developed by existing industrial power producers. Responding to the incentives described above, wind generation facilities sold directly into the power market. As well as obtaining premium prices, such projects avoided the default risks associated with state utilities and were able to generate returns of 16–22 per cent. This model continues into the final period (2009 to the present), but has been modified and increased in scale by IPPs.

Combining equity from IPPs or industrial producers, with low-cost debt from IREDA, the largest of these projects (i.e. 100MW+), have attracted international financial investors, such as Goldman Sachs, which have minimum return thresholds of around 20 per cent.

The turbine manufacturing industry has also undergone considerable evolution, from a business model of turbine construction and erection in the 1990s, to the end-to-end services model of the early 2000s. Most recently, firms are focusing on turbine supply to IPPs, combined with operation and maintenance services for these facilities (see Pearson (2013) for more detail on this).

3.5.2 The wind sector in China

Although China is rich in both wind and solar resources, wind was identified as the priority in the early period of strategic interest in renewable energy because of its economic and technical advantages. China's wind industry thus developed under the guidance of central government from the start. Grid-connected plants began to be built in the 1980s with installed capacity reaching 4.2GW in 1989. By 2012, the figure was 75.4GW.

As in India, wind sector development in China has proceeded in a number of stages. The initial phase (1986–93) demonstrated the feasibility of small-scale, grid-connected wind plants in China, again using imported technology, and largely financed by foreign loans and grants from foreign development agencies. In May 1986, the first wind farm was built in Rongcheng city in Shandong Province, using Vestas V15-55/11 turbines. At that time, the tariff for wind generation was the same as that for coal generation, with government financial support in the form of wind farm construction and research and development (R&D) programmes on wind turbines (Li *et al.* 2007).

During the first phase (1994–2003) both central and local governments implemented policy incentives to encourage the development of the industry, particularly by manufacturers who

could import technology, understand its features and adapt them to local conditions (Li, Gao and Wang 2008). A manufacturing industry with a growing production capacity emerged as a result of these efforts.

The period 2004 to 2010 was one of large-scale deployment, where central government implemented six rounds of wind power concession auctions with a total capacity of 14.05GW. Towards the end of this period (July 2009), the National Development and Reform Commission (NDRC) introduced four categories of feed-in tariff (FiT) that varied according to different regional wind resources.⁷ The design of the policy was strongly influenced by Germany's FiT. In 2009 and 2010, newly installed capacity reached 13.8GW and 18.9GW respectively.

The rapid development of wind industry over this period also owes much to local governments' project approval rights. While plants with capacity over 50MW were subject to approval by the NDRC, provincial governments could approve plants with capacity below 50MW. This resulted in the '49.5MW phenomena', where developers favoured projects below 50MW, or disaggregated large projects into several small ones, in order to shorten approval time and reduce the risk of non-approval.

China's wind manufacturing industry grew rapidly during this period. Before 2000, domestic companies' market share was less than 10 per cent. By 2009, there were 43 domestic wind turbine manufacturers, and almost 200 enterprises manufacturing turbine components. Domestic manufacturers' share of the annual market in 2009 was 87 per cent (Li, Shi and Gao 2010).

Since 2011 problems of grid connection and renewable generation integration have arisen. For grid connection, total installed capacity in 2011 was 62.4GW, while grid-connected capacity was only 45.05GW. A second problem was 'brownout', where the brownout ratio reached more than 12 per cent (Li *et al.* 2012). These issues caused central government to exert greater control over the wind sector through a longer-term strategic plan for the sector's growth.

The primary developers of wind projects in China are state-owned enterprises (SOEs). SOEs invested 85 per cent of total installed wind generation capacity in the year 2011 and 80 per cent of total accumulated capacity. At the end of 2011, there were about 60 different SOEs (subsidiaries excluded) engaged in wind power projects (Li *et al.* 2012). Joint project developers accounted for 7 per cent of the domestic market in 2011. Private enterprises, foreign enterprises and foreign joint enterprises accounted for 3 per cent, 2 per cent and 0.23 per cent of the domestic market respectively. Wind power equipment manufacturers also took 2 per cent of the market share.

For finance, wind generation projects typically have an 80/20 debt-to-equity ratio, as the 'State Council's Notice on Adjusting the Proportion of Equity in Fixed-assets Investment Projects' stipulates the minimum equity for power plant projects is 20 per cent of total investment (Qi 2013). Bank loans are traditionally of 10–15-year maturity (for solar as well as wind), with the most important institution being the China Development Bank (CDB). Renewable energy generation is designated as a 'priority industry', which means that enterprises are able to access loans with an interest rate 10 per cent lower than the benchmark interest rate for the sector. Since June 2012, this has been further reduced to a 20 per cent concession.

More than 80 per cent of wind developers (and more than 60 per cent of solar developers) in China are SOEs. State-owned commercial banks and SOEs have long and deep relations, with SOEs being the most important customers for the banks. During the planned economy

⁷ This was the 'Notice on Improving Wind Power Feed-in Tariff Policy'.

era (1949–78), SOEs were the sole customers of state-owned banks. Bank credit has thus always been the most important financing channel for China’s renewable energy developers.

In recent years, the stock and bond markets have become important supplementary financing channels. After 2010, the stock market cooled down for renewable energy stocks, and bond markets became important financing channels for developers of renewable energy.

3.6 Overview of the solar sectors in India and China

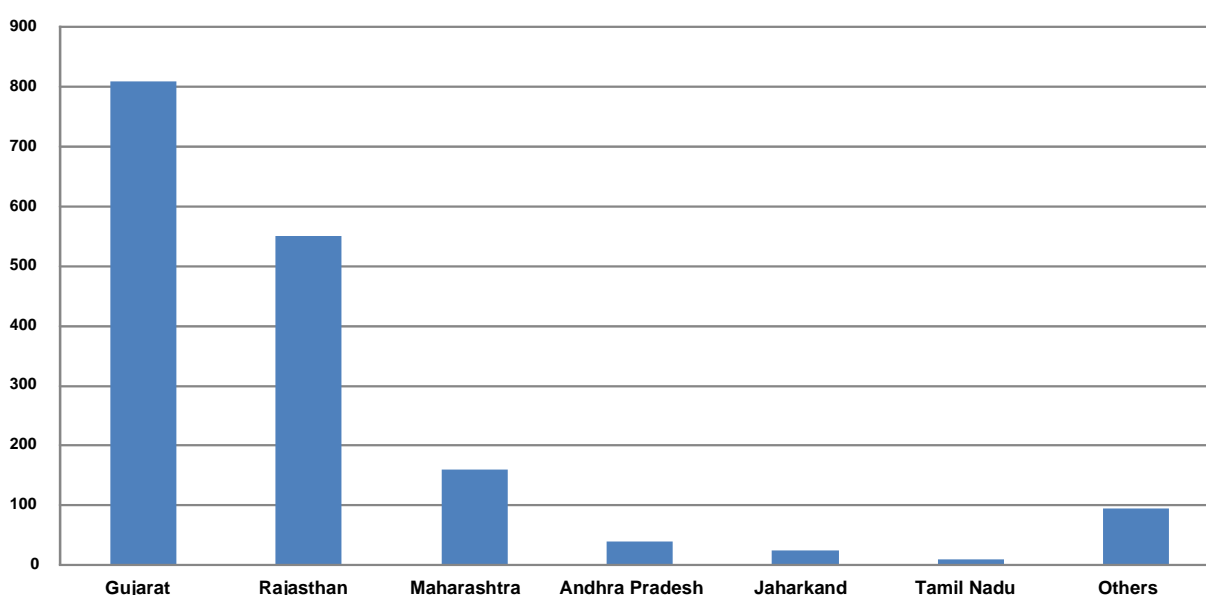
3.6.1 The solar sector in India

Prior to 2008, solar power generation in India was restricted to some off-grid applications generating a few hundred megawatts. Domestic manufacturing capacity was less than 200MW. However, the launch of the Jawaharlal Nehru National Solar Mission (NSM) in 2010 changed this situation. Together with the development of solar policies in some states, the NSM saw installed capacity in solar power rising to 2.18GW by the end of 2013. Given its relatively short lifespan, the solar sector remains small and immature compared with wind.

As well as diffusing both solar photovoltaic (PV) and solar thermal generation, the NSM was designed to create R&D capacity and promote domestic production of solar technologies. The aims of the Mission are tied quite closely to India’s obligations under the United Nations Framework Convention on Climate Change (UNFCCC), and its launch has been closely associated with the prime minister’s National Action Plan on Climate Change (NAPCC). The MNRE is the lead ministry, though a number of other key ministries have been involved with establishing the NSM.

The NSM is focused in Rajasthan, the state with the greatest solar resources. Under a different policy regime, Gujarat has also developed significant state-level capacity. The overwhelming majority of installed solar capacity is therefore concentrated in these two states, as shown in Figure 3.7.

Figure 3.7 State-level installed solar capacity (MW)



Source: Krishna *et al.* (2014, forthcoming).

Solar power facilities in India are typically smaller than the large-scale parks of China and Europe. There are three main reasons for this. First, due to perceptions of risk, many investors prefer smaller projects. Second, large land plots on which solar plants could be sited are difficult to obtain in India. Third, the solar mission had a cap on the size of solar PV projects, which was initially 5MW, revised upward to 20MW midway through phase 1.

Although the solar sector in India is characterised by a mix of firms it does not have the 'supplier's market' characteristics of wind power, which was largely driven by manufacturing firms, particularly in the early phases of development. Developers in solar power are the most important component of the solar power value chain.

Sources of debt for solar are less diverse. It has proved difficult to attract Indian commercial banks to the solar sector, with the result that most debt has been supplied by non-Indian sources.

3.6.2 The solar power sector in China

From 2000, the Chinese government began to increase electricity access in remote areas with PV micro-wind and hydro-systems, through projects such as the 'Brightness pilot project' (2000) and the 'Township Electrification program' (2001–3). These projects drove the development of domestic PV manufacturing, so that by 2003 new installations of PV in China reached 10MW and annual output of PV cells reached 8MW (Li *et al.* 2007). Compared to hydro and wind, solar costs were higher and technical challenges – such as replacing batteries – greater. As a result, support for solar generation projects in the country was stopped when the programme was completed.

Despite being rich in solar energy, therefore, the government of China did not provide policy support for the domestic solar sector before 2009. For most of its history, the solar industry in China focused on manufacturing rather than installation, with growth driven by exports. Solar generation plants built between 2004 and 2008 were financed by international donor funds.

Compared to the wind turbine industry, which was dominated by state-owned enterprises (SOEs) from the start, solar manufacturing firms in China are largely privately owned. China's first solar panel manufacturer was incorporated in 1998. Due to limited domestic and international demand, however, the growth of the industry was slow. This began to change, however, following the signing of the Kyoto Protocol in 1997, when solar generation was increasingly prioritised by a number of European countries. Tapping into the rapid growth in demand in Europe, the Chinese PV manufacturing industry developed rapidly from 2004 onwards. In 2007, China became the largest manufacturer of PV cells in the world, when output exceeded 1,000MW.

Following the global financial crisis of 2008, many countries implemented economic stimulus plans, including support for renewable energy. Demand in the global PV market increased rapidly, and China's PV industry experienced its second rapid expansion. By the end of 2010, there were 20–30 polysilicon manufacturers, over 60 wafer and cell enterprises, and more than 330 module enterprises in China (Li *et al.* 2012). By the end of 2011, total production capacity was about 40GW, compared to total global installation demand of 28GW (Fan 2012).

In response to the overcapacity of the industry, China's government introduced a national feed-in tariff for solar generation in 2011. New installed capacity reached 2.2GW in 2011, rising to almost 5GW in 2012. From almost nothing, domestic Chinese solar installation accounted for more than 15 per cent of total global demand in 2012.

Compared with wind, solar facility developers are more diversified. In 2011, SOEs accounted for 61 per cent of both installed PV capacities and cumulative PV capacity – compared with 80 per cent for wind. For other types of developers, PV equipment manufacturers' market share reached 21 per cent for new installed capacity and joint project developers' 10 per cent, while private enterprises and foreign enterprises accounted for 4 per cent and 2.78 per cent respectively.

For financing, centralised PV facilities have characteristics similar to wind facilities, typically with an 80/20 debt-to-equity ratio, and the same types of investors. The 'Golden Sun demonstration' and building integrated photovoltaics (BIPV) grants programmes introduced in 2009 reimburse 50 per cent of the required total capital for approved projects; the developer then invests 30 per cent and borrows 20 per cent from the banks in this case.⁸

In the second section of this report we examine the structure and governance of the energy sectors in India and China, and outline the scale and nature of wind and solar energy investments in both countries. The last 15 years have seen huge changes in all of these areas which, taken together, have produced each country's current level and pattern of generating and manufacturing capacity in each sector. In the third section of the report, we explore important periods in both countries to understand why investments increased (or did not), and the role that different alliances of actors in each country played in shaping these events.

⁸ China did not have on-grid household PV systems until 2012. In 2009, central government initiated the 'Golden Sun demonstration' and BIPV grants programmes to encourage distributive PV power deployment. According to the requirement of these two projects, central government would reimburse 50 per cent of the required capital for approved projects; the developers should invest 30 per cent of the total capital. The 'Golden Sun demonstration' programme was terminated in 2013 and the BIPV grants programme was terminated in 2012.

4 Comparative case studies

To address the research questions described in Section 1 of this report, case studies of the wind and solar energy sectors in India and China were undertaken. For each country, 3–4 detailed studies were conducted for each sector. Desk-based research was complemented by semi-structured interviews with key actors in each case. This section takes a comparative approach to these studies, organising them into the following categories:

1. the establishment of domestic manufacturing and development companies;
2. periods of investment intending to rapidly expand domestic manufacturing capacity;
3. periods of investment intending to expand installed generation capacity.

For each category, examples from both sectors and both countries are examined and compared. The aim is to examine the drivers of investment (both where this succeeded in its aims and where it did not), and to consider the extent to which these drivers (and their effects) differed by sector and by country. Throughout, the role of different coalitions and alliances is examined and compared.

4.1 Case study category 1: the establishment of domestic manufacturing companies

In this section we examine the establishment of Indian and Chinese companies involved in manufacturing. In the wind energy sector, the firms are Goldwind of China and Suzlon of India. For solar, we consider Suntech of China and Moser Baer of India.

4.1.1 Wind energy companies in India and China: origins and early years

Table 4.1 gives a chronology of the foundation and early years of both Goldwind and Suzlon. Although Suzlon Energy Ltd is the older of the two in their current guise – being established in 1995 – Goldwind has earlier origins, being established in 1988 as Xinjiang Wind Energy Ltd (XWE). As described in Section 2, this was a period of ‘incubation’ in China, where states began wind farm feasibility studies, based on imported foreign technologies. As we see, XWE followed this model, using grants from the Danish government to import turbines from Denmark.

The next significant development in China came in 1994, when grids were required to guarantee connection to wind facilities. While there were no significant commercial incentives for wind production in China at this stage, this was not true of India, where ‘accelerated depreciation’ was permitted for wind facility assets from 1990.

The Tanti family were industrialists in Maharashtra in the textiles sector. Because of the unreliable and very expensive power supply described in Section 2, Tulsi Tanti was actively looking for an alternative source of power. Following the introduction of the accelerated depreciation incentive, the waiving of import duties, a ten-year corporation tax holiday, and exemption from sales tax, the Tanti family decided to invest in wind as that alternative power source, buying two turbines from Südwind of Germany. After proving the commercial viability of wind, Suzlon Energy Ltd was established in 1995.

The following year saw installed wind capacity in China triple, again with money from foreign donors – this time the German ‘Gold Plan’ programme. The increase in the number and variety of imported turbines was important for the development of China’s own manufacturing capacity, based on studying and adapting existing technologies. The process continued the following year, when XWE imported 600kW turbines from Jacobs of Germany, the largest

Table 4.1 Comparative chronology of early years: Goldwind vs Suzlon

	Goldwind (China)	Suzlon (India)
1985		7th National Five-Year Plan allows wheeling, banking, and third-party sales in the energy sector.
1988	Xinjiang Wind Energy Ltd established. It is one of the earliest corporations with principal business in wind sector in China.	
1989	XWE buys 13 150kW turbines from Bonus Denmark with a US\$3.2 million grant from Danish government. Within a year, Wind Power Plant No. 1 in Daban City started generation for grid.	
1990		'Accelerated depreciation' introduced, enabling more fixed asset depreciation costs to be booked in early years. Depreciation is tax deductible at 100%. Import duties waived on wind sector goods, and five-year tax holiday established.
1993		MNRE releases official guidelines for grid-interactive wind power. Seventeen states, including Tamil Nadu, Maharashtra and other wind states, adopt these guidelines for integrating wind power within the power sector.
1994	'Wind power plants grid-connected operation regulations' introduced, requiring grids to connect wind power plants.	Tulsi Tanti installs two wind turbines to power his textile manufacturing facility.
1995		Suzlon Energy Limited founded in Maharashtra by the Tanti family.
1996	Driven by German aid programme 'Gold Plan', installed capacity increased from 2,050 to 6,100kW. Use of different types of turbine helped R&D on localisation.	Signs licensing agreement to buy turbines from Südwind of Germany and a technology transfer agreement where Südwind shared their engineering technology to enable Suzlon to install and maintain the turbines.
1997	XWE imported 600kW wind turbine manufacturing technology from Jacobs of Germany.	Südwind goes bankrupt and is acquired by Suzlon, providing manufacturing capacity.
1998	Xinjiang New Wind Science & Engineering Trade Corporation established with help from Xinjiang Autonomous Region. Ministry of Science and Technology provides 3m yuan for development of 600kW turbines.	Based on own experience, understanding of Indian textile sector, ability to manufacture at low cost in India, and links with major banks connected to the sector, Suzlon develops captive power model.
1999	Successful development and manufacture of 600kW turbines. The development process cost 40m yuan (20m in bank loans).	
2001	Xinjiang New Wind Science & Engineering Trade Corporation reorganised as Goldwind Corporation. Registered capital was 32.3m yuan, 72% from state-owned corporations and 26.73% from 'Natural person' shares.	The Tanti family closes textile business to focus on Suzlon Energy. Suzlon executes large captive generation projects for Bajaj Auto.
2002	Goldwind assembling capacity for large-sized generators. Annual production capacity of 200 sets of 600–750kW generators.	Suzlon refines turnkey model of end-to-end development. As well as sourcing sites, constructing facilities and providing operation and maintenance services, Suzlon facilitates access to debt from banking contacts and takes whole project risk onto its balance sheet. Model proves attractive to manufacturers and financiers, enabling rapid expansion to occur.
2003	Goldwind wins the first wind power concession project in China, a 100MW project in Guangdong province.	

Source: Adapted from Krishna *et al.* (2014, forthcoming) and Dong, Qi and Spratt (2014, forthcoming).

deployed in China at that stage. In 1998 the Xinjiang New Wind Science & Engineering Trade Corporation was established in Xinjiang Autonomous Region and received a grant of 3m yuan to develop 600kW turbines from the Ministry of Science and Technology. A year later, using loans of 20m yuan from state-owned banks, turbines of this size were successfully manufactured.

In its earliest days Suzlon took a very different route, signing a licensing agreement with Südwind in 1996. Under this deal, Suzlon would sell Südwind's turbines in India, but also provide installation and maintenance services. For this to be possible, Südwind agreed to share its engineering knowledge with Suzlon through a technical collaboration agreement (Lewis 2007). When Südwind went bankrupt in 1997, Suzlon was uniquely well placed to take over the business, hiring Südwind's engineers and starting manufacturing in India. At that stage, Suzlon had the capacity to produce a range of turbines, up to a size of 750kW (*ibid.*).

In 2001 the Tanti family textile business closed to concentrate full time on Suzlon. At that time, the competitors in India were Vestas of Denmark, Enercon of Germany, and NEPC, which was Indian but used technology supplied by Micon of Denmark. Based on its integrated manufacturing process based in India, Suzlon was able to offer turbines at substantially lower cost, and combined this with the development of its turnkey captive power model. While textile manufacturers faced the same problems of expensive and unreliable energy, there was little understanding of wind, and concerns about the financial risks involved – not least because of the high fixed capital costs needed to install wind turbines. The end-to-end model developed by Suzlon – and rapidly adopted by its competitors – was designed to address these concerns. Tulsi Tanti describes the approach as follows:

We identify the sites, conduct the wind measurement study, the budgeting, build the substation and grid connections; then we take the responsibility for twenty years of operating maintenance.
(Tulsi Tanti, quoted in Mazumdar 2010)

As well as project and operational risks, Suzlon also assumed financial risk for projects. A problem for developing renewable energy projects in India has been – and remains – access to long-term debt finance. Commercial banks have been reluctant to commit the maturities these projects need. When banks do lend, it is generally at very high interest rates and after a lengthy period of due diligence.

Suzlon short-circuited this process by building on pre-existing relationships with a small number of banks, such as the State Bank of India and the Punjab National Bank, which they had dealt with in the textile manufacturing business. Suzlon's business model saw them take the entire project debt from these banks onto their own balance sheet, eliminating risk for the client. For the banks, these loans 'recourse' in that they were backed by Suzlon's assets (i.e. not just the project's assets), again reducing perceptions of risk. The final part of the 'package' was the wheeling and banking services allowed since 1985, which enabled producers to manage intermittent energy supplies.

One major project executed by Suzlon was seminal in establishing the above as the standard model in the Indian wind sector. This was a 62.5MW captive generation project for Bajaj Auto, one of India's leading automobile firms, in the Pune area of Maharashtra. The project allowed Bajaj Auto to sharply reduce their energy costs through wheeling and banking arrangements with the state utility. In combination with the various tax incentives available, operating costs were significantly reduced.

Having refined and demonstrated the viability of the model, Suzlon's presence in Maharashtra expanded rapidly through the Tanti family's existing business network in the textiles business. By 2004, Suzlon had become a dominant player in the state and had established manufacturing facilities in close proximity to other wind-rich states – Tamil Nadu and Gujarat. Understanding of the textiles business helped Suzlon bring the captive generation model to other textile industry clusters in these states. In time, Suzlon's share of the India domestic wind market rose to 50 per cent.

In 2001 Xinjiang New Wind Science & Engineering Trade Corporation was reorganised as the Goldwind Corporation, with the original SOE retaining a 70 per cent ownership stake. At this stage, domestic market opportunities were very limited. In 1999, ten sets of 600kW wind turbines were produced, four of which were sold to XWE. In 2000, an army troop in Xinjiang bought two sets, while Chengde Power Industry in Hebei province ordered six sets in 2001. The strategic goal of central government, however, was to develop an international competitive wind manufacturing sector that would also develop energy generation capacity for the domestic market. This required both research and innovation, and a move to large-scale manufacturing.

The lengthy period of R&D and technology transfer that had taken place in Xinjiang before the launch of Goldwind was the foundation of this process. After the successful manufacturing of a 600kW turbine in 1996, the focus shifted to new wind generation technologies, rather than mimicking that of foreign firms. To further this, Xinjiang New Wind Science & Engineering Trade Corporation, and then Goldwind, developed a formal research partnership with VENSYS of Germany.

Despite very limited sales, production capacity could expand rapidly due to ready access to cheap finance.⁹ By 2002, annual production capacity was 200 600–750kW turbines, capable of generating up to 150MW of power. With the foundations built, the Chinese government launched its first concession in 2003, for a 100MW wind power plant in Huilai Shipaishan, Guangdong Province.

Importantly, the concession tender policy was developed jointly by central government, local government, grid companies and wind turbine manufacturers. China's goal was not only to support domestic manufacturing industry, but to develop the country's own brand of wind turbine, which could compete in the export sector. To facilitate this, the wind concession policy required applicants to be a consortium of both manufacturers and facility developers. The local content requirement for wind turbine was set at 70 per cent, effectively excluding international manufacturers from China's wind power market. Consequently, although Goldwind had only four years' experience in turbine manufacturing, it won the competition over international competitors GE and Mitsubishi despite their having vastly more experience. Goldwind has continued to win a significant share of wind farm concessions in subsequent national tender processes.

Discussion of drivers and alliances

By 2003 both Suzlon and Goldwind had risen to become very successful players in their domestic wind sectors. For both manufacturing and installation/generation, they were at the forefront of developments. The routes taken to this position, however, could hardly have been more different: Suzlon's formation can largely be explained by the identification of a business opportunity by the founders, and the refinement and scaling-up of the business model designed to exploit this opportunity; for Goldwind, there was no business opportunity at the outset – it had to be gradually and progressively created over a number of years.

⁹ As described in Section 2, wind sector companies could borrow at a concessional rate from state-owned banks (10% below the industry benchmark) as wind was designated a 'priority sector'.

Goldwind was the product of a strategic decision to exploit China's wind resources and develop a globally competitive manufacturing sector. Generation feasibility was trialled in various locations, using imported technologies, with R&D used to learn from these goods. The use of public grants to support this research, and the channelling of cheap finance from state-owned banks to fund expansion in productive capacity, formed the next part of the story. The structuring of the first wind farm concession, such that Chinese firms were guaranteed to win, completed the process. By 2003, a 'business opportunity' had therefore been created – supplying the growing Chinese domestic market. Manufacturing firms such as Goldwind were in place to take advantage of this opportunity.

In some ways, Goldwind was an unlikely 'national champion' to emerge from this process. Xinjiang is a remote area with limited science and technology capacity and poor transport links compared to many other regions in China. This may also have been an advantage, however. As we have seen, much of the early development of wind in Xinjiang was funded by foreign donors, and this type of funding was more available than in more developed provinces. The local government took full advantage of the possibilities this created.

With respect to alliances, we therefore see strong relationships between local government and SOEs in Xinjiang, who were able to leverage foreign aid to establish a toehold in the wind sector, and then access government grants to support R&D and the creation of manufacturing capacity. Similar processes presumably occurred in other regions where manufacturing firms emerged.

For the first wind concession auction, these local actors combined with central government agencies to create a structure that supported the strategic aim of creating internationally competitive manufacturing firms. Concession tenders were developed jointly by central government, local government, grid companies and turbine manufacturers. A viable 'business opportunity' was thus created and exploited by a number of actors, whose interests – though different – were aligned.

Suzlon was very different. The company was formed to exploit a potential business opportunity: to increase the family's textile business by reducing the costs and increasing the reliability of its energy supply. This was not a straightforward business opportunity, however: it existed largely because of problems in India's state electricity utilities, which led to artificially expensive and unreliable energy supplies. Wind also had other attractions, notably the various tax incentives described and access to state wheeling and banking services.

What turned this from a potential to an actual business opportunity were the actions of the Tanti family, particularly their ability to identify the actors needed to make the model work, whose interests were aligned sufficiently to incentivise them to join his 'alliance'. Here we can see the importance of sector-specific knowledge and extensive contacts. Tulsi Tanti took advantage of the features above to solve his own problem of expensive and unreliable power and spotted the opportunity to replicate this approach. He also understood what was needed to make this work.

Suzlon's end-to-end model, which addressed the knowledge gaps and risk aversion of potential customers, was key. What allowed this model to flourish, however, was the extensive network of relationships that Tanti enjoyed with fellow manufacturers in his own and surrounding states. Based on his own experience, he could 'sell' the concept to them convincingly. It helped enormously that Suzlon could facilitate access to long-term debt from commercial banks, a rare commodity in India.

The banks did not lend just because they knew and trusted Tanti. The willingness of Suzlon to take all the financial risks of projects onto their balance sheet and to give creditors 'recourse' to Suzlon's assets beyond the individual project were very important elements. Again, however, it was knowledge of local banks that enabled Suzlon to align their interests

in a business model. While Suzlon emerged to take advantage of a potential business opportunity, it was their insider knowledge that helped them to understand what was needed to exploit this potential, and their ability to forge the right alliance of actors that turned this potential into reality.

In China, therefore, we see a top-down process, where state actors strategically constructed a potential business opportunity, and then forged an alliance of public and private actors to exploit this. In India, in contrast, we have a bottom-up process, where a commercial actor spotted a potential business opportunity – which was itself the result of both deliberate and unconscious action by state agencies – and put together the alliance of other commercial actors needed to take advantage of this opportunity.

4.1.2 Solar energy companies in India and China: origins and early years

Table 4.2 gives a chronology of the early years of two solar manufacturing firms – Suntech of China and Moser Baer PV (MBPV) of India. The different timeframes for each reflect their different ‘birthdays’. To enable comparison, the stages of each company’s evolution are aligned rather than the actual dates.

Table 4.2 Comparative chronology of early years: Suntech vs Moser Baer PV

Suntech		Moser Baer	
2001	Suntech established in Wuxi with capital of US\$7.2m. Founder contributes US\$0.4m cash and intellectual property for ‘technical’ and ‘cash’ shares of US\$1.6m. Coordinated by Wuxi municipality, seven SOEs invest US\$5.2m.	2005	Moser Baer Ltd, the world’s largest manufacturer of silicon-coated compact discs, responded to increased competition and declining demand by deciding to diversify into solar PV manufacturing.
2003	State-owned shareholders guarantee Suntech’s external loans to fund expansion of productive capacity.	2006	Moser Baer Photovoltaics (MBPV) formed. US\$17m invested in R&D and production, and undisclosed amount into Solaria, a US PV technology company. Invests US\$7m in SolFocus, which is developing innovative concentrated photovoltaic (CPV) technologies, and a nanotech firm.
2001–2005	Wuxi municipality won over 11 national, provincial- and city-level research grants for Suntech totalling 39.2m yuan. Produces solar cells with high conversion rate. Annual production capacity increases to 50MW, the 8 th largest in the world.	2007	Announces agreement with Deutsche Solar AG, a silicon wafer manufacturing firm, and acquires 40% of Solarvalue AG (Slovenia) to ensure supply of silicon wafers. Crystalline silicon (c-Si) PV production grows to 80MW, and plans announced to increase to 200MW by 2009. Orders of US\$100m announced and US\$250m investment received in bonds and equity.
2005	Private equity consortium invests in Suntech. Goldman Sachs’ stake is US\$22.5m. Before listing, SOEs withdrew their shares with coordination of Wuxi municipality. This was a crucial move to enable Suntech to be listed. Suntech floated on New York Stock Exchange, valuing company at US\$342.3m.	2008	Plans to reach 600MW capacity with investment of over \$1.5bn. Enters into a ten-year contract with LDK Solar for supply of high-quality silicon wafers. Completes trials for the world’s most efficient thin film modules. Signs long-term contracts worth US\$500m with a number of European firms, and raises US\$100m from investors including Nomura, CDC Group, Credit Suisse, Morgan Stanley, IDFC PE and IDFC. Firm valued at US\$1.4bn.

Source: Adapted from Krishna *et al.* (2014, forthcoming) and Dong *et al.* (2014, forthcoming).

The 'father' of Suntech, Shi Zhengrong, was born in Yangzhong, Jiangsu province. After gaining a Masters degree from Shanghai Institute of Optics and Fine Mechanics, Shi attended the University of New South Wales in Australia, where he was awarded a Doctorate in solar power technology. He acquired Australian citizenship and returned to China in 2001 to set up Suntech Power and look for a local government to back him in the development of a solar PV manufacturing company.

Before coming to Wuxi city, Shi had already pitched his idea unsuccessfully to the governments of Qinhuangdao, Dalian and Shanghai. In January 2001, however, the Wuxi government agreed to support the project on two conditions. First, Shi Zhengrong had to invest his own cash; and second, his technology and intellectual property would belong to the joint-venture company, preventing him from working with anyone else. Shi Zhengrong therefore held 25 per cent of Suntech's shares – 20 per cent of these were 'technology shares', representing the contribution of his intellectual property, and 5 per cent were cash shares, for which he paid US\$400,000.

Although the Wuxi government did not invest directly, it coordinated investment by seven SOEs, who put in US\$5.2m to become Suntech's major shareholders.¹⁰ The Wuxi government thus played the roles of venture capitalist, coordinator and, with the appointment of the former Head of the Economic and Trade Commission of Wuxi City, Li Yanren, chairman of the board.

During this early period, access to capital was the main constraint. Unlike wind, solar was not a 'priority' sector and did not have the same ready access to funds from state-owned banks. In early 2003, the company began to seek loans, and Li Yanren persuaded four of Suntech's SOE shareholders to provide guarantees for a loan of about 50m yuan. Building on this, Li took advantage of his political network to obtain a low-interest loan through the Wuxi Labour Bureau (He 2006).

Why was the Wuxi government so supportive? Wuxi city is in Jiangsu province, close to Shanghai, Nanjing and Suzhou. Surrounded by 'megacities', the Wuxi government was looking for a niche within which to build local economy competitiveness; its solution was 'hi-tech'. In 1999, the Wuxi government established a venture capital company – Wuxi Venture Capital Group – to provide seed capital for high-tech start-ups. At that time, the government had very limited knowledge of how to run such a company. Suntech was the first project that was invested in. After Suntech, the Wuxi government established a '530 Program', which promised to support 30 group start-ups within five years. Small and medium-sized high-tech companies could apply for support under this programme.

Although not supplying finance directly, the Wuxi government did facilitate access to a variety of research grants for Suntech, amounting to more than 39m yuan, which was crucial in enabling the company to survive. In conjunction with the fundraising efforts of Li Yanren, this allowed production for the export market to expand rapidly. The timing was perfect. Led by the long-standing feed-in-tariff in Germany, other European countries began to provide support for small, distributed PV capacity. In 2004, this type of spending accounted for more than 22 per cent of global renewable energy investment. Tapping into this growing market, Suntech was manufacturing solar cells with 50MW of capacity by 2005, making it the eighth largest manufacturer in the world.

From 2004, Suntech's founder had begun to plan for withdrawal of the state-owned shares to allow a flotation of Suntech on the stock market. A proposal was submitted to Wuxi municipality, strongly supported by the party secretary of Wuxi CPC (Communist Party of

¹⁰ Suntech's company shareholders were Wuxi Venture Capital, Wuxi High-tech Venture Capital Fund Managers and Wuxi High-tech Venture Capital Co. All three companies were government controlled. Other backers were the Wuxi United Trust Company, Little Swan Group (manufacturer of washing machines), Mercury Group (from the textile industry) and Wuxi Wo Group.

China) Committee on condition that the interests of all investing parties were protected. After negotiations with the investors, agreement was reached in March 2005. Wuxi Venture Capital got the lowest return (ten times its initial investment), while another received 23 times its initial investment (He 2006).

Suntech's growth and export performance, and expectations of continuing growth in global demand, attracted the attention of international private equity investors. When the SOEs exited from Suntech, a consortium of private equity funds invested around US\$100m. Goldman Sachs' stake was US\$22.5m. Suntech was floated on the New York Stock Exchange (NYSE) in December 2005, with an initial valuation of US\$342m. The share price rose rapidly in the aftermath. The deal has become legendary in the private equity sector, with all the investors exiting with at least ten times their initial investment. By 2008, Suntech was valued at £2.8 billion.

In 2008, Moser Baer Photovoltaic (MBPV) was valued at US\$1.4bn, about half that of Suntech. Given that it had only begun operations in 2006, however, this was impressive. The future appeared bright. The parent company was founded in the 1980s by Deepak Puri (who would later participate in high-level discussions on the National Solar Mission). Moser Baer Ltd was the world's largest manufacturer of compact discs. Facing increasing pressure from new technology, slowing global growth and oversupply in the industry, the son of the founder, Ratul Puri, persuaded the board to diversify into solar PV, using their expertise with silicon materials. With an initial investment of US\$17m, MBPV was founded in 2006.

Given the timings, it seems likely that the Suntech flotation – as well as the others which followed – and the 'exuberance' surrounding the solar sector in global financial markets influenced the decision of Moser Baer to diversify. There was some basis for this optimism, however. Demand for solar cells has grown steadily, driven by the European markets, underpinned by national FITs. MBPV anticipated rapid growth in demand for solar cells in Europe, as well as in the more developed economies of East Asia. Domestically, there were already rumours that India would shift into solar significantly, and the firm estimated demand of 1,000MW per year within two years.

MBPV planned to tap into this market in two ways. First, the well-known low-cost assembly route would see polysilicon sourced globally, with modules assembled in India, where both capital costs and operational costs are lower. The second part of the strategy was to develop new technologies. MBPV therefore acquired two technology firms in the US (SolFocus and Stion), which were researching new technologies. MBPV also formed strategic relationships with other companies. In 2007 a strategic sourcing relationship was agreed with Deutsche Solar AG. MBPV also acquired OM&T BV, a Phillips-owned optical technology and R&D subsidiary based in the Netherlands. March 2007 also saw a technology partnership signed with Applied Materials USA.

Trials of 40MW c-Si PV production facilities began in March, with plans announced to expand capacity to 200MW by 2009, based on investment of US\$250m. By summer 2007, US\$100m of orders had been received, and MBPV raised US\$100m through a foreign currency bond issuance.

Contracts and orders continued to be announced throughout the year, and October 2007 saw US\$100m raised from a consortium of IDFC PE, CDC Group (the UK's development finance institution), and GIC Special Investments. Towards the end of the year, the company signed a memorandum of understanding with the Government of Rajasthan for a 5MW solar farm (then India's largest).

This pattern of planned expansion of production (e.g. US\$1.5bn investment announced to expand production capacity) and new contracts continued in 2008. The same was true of innovation and R&D: trials for amorphous silicon modules, then the world's most efficient,

were completed. By September 2008, MBPV had an annual production capacity of 120MW c-Si and 40MW thin film modules, and raised a further US\$100m from a group of investors: Nomura, CDC group, Credit Suisse, Morgan Stanley, IDFC PE and IDFC. At the time of this investment, the firm was valued at US\$1.4bn.

Discussion of drivers and alliances

By 2008, Suntech and MBPV were similarly poised to benefit from the continued growth of the global solar PV market. While both had reached this position in rather different ways, there are more similarities than was the case with the wind sector firms considered above. For both Suntech and MBPV, a common factor was the rapid growth in global demand, largely driven by the European distributed PV market.

For Suntech, the entrepreneurial ambitions of an individual, Shi Zhengrong, coincided with the desire of a city (Wuxi) to develop a hi-tech economic 'niche'. The Wuxi government then proceeded to forge an alliance of actors – SOEs, central government research grant awarding bodies, and financial investors – to enable Suntech to reach sufficient scale to exploit the growing business opportunity created by rapidly expanding global demand.

While the Wuxi government was the key actor in forging this facilitating alliance, it was Shi Zhengrong who was the main driver behind the listing of Suntech on the NYSE. Shi Zhengrong 'sold' this idea to key contacts in the Wuxi government, who then facilitated the withdrawal of SOEs as Suntech shareholders. Shi Zhengrong also brought the consortium of private equity investors into the alliance at this stage, providing the link to the NYSE. All of these actors profited handsomely.

In contrast to Suntech, there is no evidence of influential alliances involved in MBPV's launch and early development. Rather MBPV was created in response to deteriorating business opportunities in one sector (compact discs), and the expectation of increasing opportunities in another (solar PV). The success of Suntech and others no doubt provided an alluring example, and the company could also draw upon its expertise in related processes, as well as the resources of its parent company.

An important difference between the two companies relates to market timing. Suntech emerged in anticipation of the growth of global solar demand, while MBPV was created in response to this demand. As a result, by 2003, Suntech was much further down the road of capacity expansion, holding a significant share of the global PV market. In facilitating this, Wuxi's government behaved as a venture capitalist might, taking a 'bet' on the growth of an export sector. Unlike a private venture capital firm, however, it had the contacts and influence needed to forge an effective alliance to get Suntech to a position where it could take advantage of this potential business opportunity.

4.2 Case study category 2: periods of investment to expand domestic manufacturing capacity

In the first part of this section, we continue to chart the fortunes of Goldwind and Suzlon. We then consider the series of foreign solar listings by Chinese firms that followed Suzlon's flotation. For solar in India, efforts to expand domestic manufacturing in the National Solar Mission are examined.

4.2.1 The expansion of wind sector manufacturing in India and China

Table 4.3 charts the expansion of Goldwind and Suzlon from 2003 to the present. As we have seen, by 2003 both firms had developed the capacity to manufacture wind turbines at scale, and had developed a market to sell these projects. For Goldwind, this came from its success in China's first wind power concession; for Suzlon, it was the refinement of its

turnkey captive power model. The paths they subsequently followed, however, were very different.

Table 4.3 Chronological comparison of wind sector manufacturing expansion: Goldwind vs Suzlon

	Goldwind	Suzlon
2004		Suzlon Energy A/S founded in Denmark. Citicorp and Chryscapital invest US\$24m for a collective stake of 15%.
2005	The first 1.2MW generator set of Goldwind's goes into operation in Daban City.	Acquires Hansen Transmissions International for US\$520m. Invests US\$14m in manufacturing facility Minnesota, US. Takes over Sarjan Engitech (components firm).
2006	Goldwind reaches 33% domestic market share. Its sales turnover ranked no. 1 in China and no. 10 in the world.	Enters Italian, Australian, South Korean markets. Gains 53% market share in India.
2007	First 1.5MW generator sets put into operation in Daban City. Capital increases to 450m yuan. Listed on Shenzhen Stock Exchange increasing capital to 500m yuan.	Acquires 33% of REpower (German offshore specialist) for €453m. Raises US\$500m through zero-coupon convertible bonds in USA. Raises US\$552m through a follow-on offer of equity. Hansen listed on the London Stock Exchange (LSE) for US\$400m.
2008	Goldwind wins concession for 811MW in Gansu Jiuquan city. Buys 70% equity of VENSYS and establishes R&D centres in China and Germany. First wind turbine manufacturer with fully independent R&D capacity and intellectual property rights.	Acquires further 37% stake in REpower. SE Forge issues equity shares and raises US\$80m. Sells 10% stake in Hansen. Completes a blade retrofit programme, adding significantly to the company's debt. Completes a US\$383m rights issue.
2009		May: Sells 2% stake to raise US\$50m. July: Raises US\$175m through offer of global depository receipts.
2010	Lists on Hong Kong Stock Exchange, raising HK\$8bn. CDB provides US\$43.6bn to renewable energy manufacturing companies.	Reaches 5,000MW of installations in India – nearly a third of the Indian market.
2011	Signs 'Strategic Cooperation Agreement' with Industrial & Commercial Bank of China (ICBC), which loans 10bn yuan to support operations.	Exits Hansen by selling its remaining stake. Defaults on its Foreign Currency Convertible Bonds (FCCBs).
2012	Goldwind second largest manufacturer in China, as China becomes the largest manufacturer of wind turbines in the world.	Enters into a corporate debt restructuring programme with a consortium of 19 banks/lenders, raising working capital limits. Sells 75% of its Chinese subsidiaries.

Source: Adapted from Krishna *et al.* (2014, forthcoming) and Dong *et al.* (2014, forthcoming).

China was explicit in its wish to develop an internationally competitive industry in this sector, and the R&D of the preceding 15 years had been explicitly designed to put in place the foundations to make this possible. The fact that Goldwind won the first wind concession tender in 2003, therefore, demonstrates that the company was seen as one of China's 'national champions' in the sector.

Table 4.4 shows how Goldwind continued to be awarded significant shares in wind farm concession tenders – data for 2004 and 2005 are unavailable, but there is no reason to think this was not also the case in these years. In each tender, Goldwind supplied between 20 per cent and 50 per cent of the turbines deployed in China, and this was a period of rapid expansion in installed wind capacity in the country.

Investment in the domestic wind sector rose from virtually nothing before 2003 to more than US\$30bn per year by 2010. A sizeable share of the market was awarded to Goldwind, enabling the firm to steadily increase production capacity. By 2006, Goldwind had become the largest turbine manufacturer in China, with 33 per cent of the domestic market. This large and growing market enabled Goldwind to achieve significant economies of scale in production, improving the competitiveness of exports. In 2006, Goldwind was the tenth largest manufacturer globally.

Table 4.4 Wind concession tenders in China, 2003–2009

	Year	Bid scale (MW)	Tender won by Goldwind (MW)
First tender	2003	200	100
Second tender	2004	300	N/A
Third tender	2005	450	N/A
Fourth tender	2006	700	200
Fifth tender	2007	950	300
Sixth tender	2009	5,250	1,300.5

Source: Dong *et al.* (2014, forthcoming).

In the same year, Suzlon's share of the (now smaller) Indian market reached 53 per cent. Partnering with industry associations such as the Indian Wind Energy Association, Indian Wind Turbine Manufacturers Association and the Indian Wind Power Association, Suzlon sought to sell its successful turnkey model to different industrial sectors. The model was based on expansion, which ensured that cash flows rose sufficiently fast to enable Suzlon to service the rising level of debt on its balance sheet. This rapid growth attracted investments from the US-based Citibank and ChrysCapital, who invested nearly US\$25m. However, Suzlon's growth-aggressive model was constrained by the limits of the Indian market, and the decision was taken to expand out of India.

The strategy had three elements: vertical integration; establishing manufacturing centres close to demand centres; and creating an international R&D network to drive innovation. The approach to vertical integration entailed both forward (into distribution) and backward (into component manufacturing) elements. The supply of critical components such as gearboxes was controlled by a few firms whose production capacity effectively determined the global supply of turbines. By acquiring these capabilities, Suzlon would begin to free itself of these constraints (serving its growth-based model). Also, because of limited supply, component manufacturing was the source of a large proportion of total profits in the wind supply chain, thereby boosting company profits. Locating manufacturing close to sources of demand was positive for production costs, while a continuing focus on R&D was designed to ensure that Suzlon remained competitive on technical grounds.

The strategy was implemented in a flurry of acquisitions. Within a few years Suzlon acquired AE Rotor in the Netherlands, set up manufacturing facilities in Minnesota, established a joint venture with Elin Motoren in Germany, and founded global headquarters in Denmark. Without the expertise and access to funds that firms such as GE and Siemens possessed, Suzlon had grown to rival existing giants in the global wind turbine industry.

Goldwind was also heavily involved in R&D. Unlike Suzlon, however, this was not achieved by purchasing existing firms. In 2005, the NDRC approved a two-year grant of 220m yuan to support domestic industrialisation of the renewable industry. Wind equipment localisation was one of the five key areas the grant supported. Goldwind had received research funding to enable it to develop its 600kW turbines, and a further grant was received under the 10th Five-Year Plan, and yet another to develop a 1.2MW direct-drive turbine, which would no longer require the gearboxes that Suzlon would place so much store in acquiring the capacity to manufacture. Following the third of the 2007 concessions that it was awarded, Goldwind

had expanded sufficiently by 2008 to acquire a 70 per cent stake in its long-term technical cooperation partner, VENSYS of Germany. In 2008, the National Wind Power Engineering and Technology Research Centre was established within Goldwind.

To fund its expansion, Suzlon listed on the Bombay Stock Exchange in 2005, raising US\$350m. Its shares were oversubscribed nearly 40 times. In 2006, the company bought Hansen transmissions, a supplier of cutting-edge gearboxes to Vestas, Siemens and Gamesa, and continued to expand and diversify. The move into offshore wind was a major strategic decision taken at this time.

While Suzlon was diversifying its operations, its Indian business still made up the major proportion of its revenues (60 per cent in 2011). From 2007 onwards, Suzlon began facing competition to its model of end-to-end services. Its capacity to absorb this slowdown in demand was limited, however, as its debt-heavy model and acquisition-based growth became increasingly difficult to fund. Between 2007 and 2008, Suzlon raised funds from multiple sources, such as the listing of Hansen and the sale of a 10 per cent stake in the firm. In the same year, doubts about the reliability of Suzlon's products began to emerge in the United States – where a number of turbines developed cracks in the rotor blades. The firm had to invest heavily in a blade retrofitting programme.

In 2009 the Indian government introduced policies that further undermined its captive power model. Accelerated depreciation was reduced, with incentives shifting to generation rather than tax advantages for installing capacity. Project sizes became larger, and manufacturing was increasingly separated from other wind sector activities. While still a key turbine supplier, Suzlon faced greater competition from new players. Between 2007 and 2012, the firm's market share dropped to 34 per cent.

By 2011, Suzlon's debt had grown to US\$200m and it began to default on foreign currency bonds. In 2012, the company entered a debt restructuring programme with a consortium of 19 banks and other creditors. By 2013, its market capitalisation had fallen to US\$450m, from a high of US\$1.5bn.

Goldwind has coped with competitive global market conditions much better. After raising HK\$8bn in its 2010 listing, the company signed a 'Strategic Cooperation Agreement' with the Industrial & Commercial Bank of China (ICBC), which provided loans of 10bn yuan to support operations. Goldwind remains integral to the expansion of domestic wind capacity in China, and is one of the largest manufacturers of wind turbines in the world. Its 1.5MW turbine is the most widely installed turbine globally.

Discussion of drivers and alliances

In the previous section we saw that the birth and early expansion of both Goldwind and Suzlon were the result of consciously forged alliances. For Goldwind, this was a top-down process driven by central government, involving public and private actors. For Suzlon, we see a bottom-up process, with an alliance largely formed of commercial actors, and put together by Suzlon itself.

The expansion of manufacturing capacity at Goldwind depended on the firm maintaining a significant share of a growing domestic market, and was a continuation of the original strategy, with the same actors involved. Suzlon, in contrast, had forged an alliance suited to exploiting the business opportunities created by the very specific circumstances of a few states in India. When it reached the limits of this market, and took the decision to expand globally, a new alliance had to be created, and Suzlon attempted to do this through an aggressive series of acquisitions and injections of new finance from different investors. The model proved less effective outside of India, however, and global demand conditions also turned against Suzlon – fatal to a firm based on debt-fuelled growth.

The Goldwind alliance provided a firmer foundation than that of Suzlon. In part, this may be due to a wider range of actors – public and private, national and local. It may also be due to its strategic rather than opportunistic nature. This helped Goldwind adapt to changing global conditions, where Suzlon could not. Suzlon's early success was due to a unique set of conditions. Its attempt to expand internationally was always precarious. Goldwind had the support of a huge and growing domestic market, as well as access to 'patient capital' when it was needed. Suzlon faced a declining domestic market and was reliant on ever-increasing levels of commercial debt to finance its aggressive expansion. When things went wrong, Suzlon did not have the resilience to cope, and could not rely on support from other members of its fragile 'alliance'. When market conditions turned against Goldwind, in contrast, new finance was forthcoming from China's state-owned banks, mandated to support firms in 'strategic' sectors.

4.2.2 The expansion of solar sector manufacturing in India and China

In this section we examine two contrasting experiences of attempts to expand solar manufacturing capacity. The first is the period from 2005 to 2007, where the example of Suntech's listing was replicated by a number of Chinese solar companies. The second is the attempt to expand Indian manufacturing capacity as part of the launch of the National Solar Mission in 2009. Unlike previous cases, these are not directly comparable, so a chronological approach is not used.

Table 4.5 shows the spate of listings on overseas stock markets that followed Suntech's in 2005. In less than two years, more than US\$2bn was raised.

Table 4.5 Listing events of PV manufacturers from 2005 to August 2007

Date	PV manufacturer	Exchange market	Capital raised (US\$m)
14 Dec 2005	Suntech (STP)	NYSE	342.3
Aug 2006	ReneSola Ltd (SOL)	LSE (AIM)	50
9 Nov 2006	Canadian Solar	NASDAQ	107.8
18 Dec 2006	Trina Solar	NASDAQ	150
19 Dec 2006	Trina Solar (TSL)	NYSE	98
21 Dec 2006	Solarfun Power (SOLF)	NASDAQ	150
7 Feb 2007	JA Solar (JASO)	NASDAQ	240
11 May 2007	Yingli Solar (YGE)	NYSE	319
17 May 2007	China Sunergy (CSUN)	NASDAQ	93.5
1 June 2007	LDK Solar (LDK)	NYSE	469.368
6 July 2007	Jetion Solar	LSE (AIM)	62.13

Source: Dong *et al.* (2014, forthcoming).

As well as the companies themselves, there were two main drivers of this investment spike: international private equity investors and local governments in China. For private equity investors, the example of Suntech was tantalising: Goldman Sachs invested US\$22.5m in Suntech in 2005 and recouped this investment more than 16 times over. Other banks and investment funds were eager to get on the bandwagon and take advantage of the very buoyant market conditions that existed before the start of the global financial crisis. This was further supported by positive market sentiment towards the solar sector and by China's reputation for manufacturing prowess.

For local governments, facilitating the listing of PV manufacturers brought three benefits. Prior to listing, Chinese firms would register a new company in the Virgin Islands or Cayman Islands, which would be the institution to be listed. As a result, the financing raised and repatriated to China by these firms could be categorised as 'foreign investment', an area on which local government officials were evaluated. Second, the listed companies used the

finance raised to expand local production capacity – this could be accounted as a ‘fixed asset investment’ in their evaluation. Third, raising external finance to fund increased production meant that local governments did not face the pressure of securing funds for the companies themselves.

There were thus good reasons for each local government to support these listings, and excellent commercial reasons for private equity investors to do likewise. The result was a very large, and uncoordinated, expansion in total solar panel supply from 2007–8 onwards.

In the previous section, we saw that Moser Baer PV was well poised by 2008: order books were filling and investors were convinced enough to commit significant sums. By the end of the year, however, a number of challenges had arisen. The first was excess supply (global capacity of 12GW against demand of 7GW) in polysilicon. This was caused by two factors: first, the rapid expansion of Chinese firms’ capacity; and second, falling European demand as subsidies were reduced in the light of the global financial crisis. As a result, margins in the global module assembly market fell sharply. MBPV, now a 100+MW firm, could not compete with the large Chinese firms that were looking to expand capacities up to 1GW. To make matters worse, MBPV’s investments in R&D had not produced any significant new technologies to change this picture.

During this period, the National Solar Mission began to take shape. The managing director of MBPV, who had been the head of the Renewable Energy Committee of the Confederation of Indian Industries, was a part of these early discussions, as were representatives of industries such as electronics and semiconductors. These industry representatives lobbied hard for support for Indian manufacturers, which would protect and nurture a domestic manufacturing capacity – a core aim of the NSM. Accordingly, the first phase of the NSM contained a domestic content requirement for the cells and modules to be used in the new solar park facilities. However, this only applied to c-Si (rather than thin film), as this was considered the technology where Indian manufacturers had capacity.

This decision was to have large unintended consequences, however, when project developers chose to source their modules from foreign solar manufacturers, circumventing local content requirement by buying thin-film technologies, despite their technical inferiority. There were two main reasons for this. First, developers claimed that locally manufactured modules were not cost-competitive with foreign alternatives, despite manufacturers such as MBPV offering delayed payment schemes and long lines of credit. Second, commercial banks in India were not prepared to supply debt financing at all, or not on reasonable terms and for suitable maturities. With the exception of multilateral financing institutions such as the International Finance Corporation (IFC), the primary sources of debt finance were Chinese and US export-import (Exim) banks. Supporting their own manufacturers, who were struggling due to global oversupply and falling prices, these Exim banks provided very cheap debt finance, with interest rates below 7 per cent for developers prepared to purchase products from their home countries. As a result, 75 per cent of the projects in the first phase of the NSM utilised foreign-made thin films.

Moser Baer has since successfully repositioned itself as a vertically integrated project developer working across different parts of the energy sector. In 2011, the only other large local manufacturer, Tata BP Solar, announced that the two entities (Tata and BP) were parting ways. By 2013, manufacturing capacity in India was barely 1,500MW.

Discussion of drivers and alliances

The benefits of long-term ‘patient’ capital can be clearly seen in the Goldwind case, and its lack is central to both case studies of solar manufacturing expansion. A key driver of the listings of Chinese PV manufacturers, and the subsequent overly rapid expansion of global supply, was the desire of international private equity firms to profit from ‘exuberant’ market sentiment. The fact that this motivation matched well the incentives facing local government

officials in China was also key. This is an example of relatively stable alliances between solar manufacturers and local government in China becoming ‘unbalanced’ when they are joined by new actors attracted by the desire to get on the ‘bandwagon’.

This happened in a period of buoyant market sentiment, which was fuelled by competition between local governments in China pursuing their own interests in an uncoordinated way. There was thus no constraint on the ability of these new alliances to pursue the interests of its members. The resulting overcapacity in the global manufacturing sector shows how alliances can ‘over-exploit’ business opportunities when they do not face constraints on their ability to achieve members’ interests.

The failure of the NSM to support the development of the Indian solar manufacturing sector is also related to the lack of ‘patient’ capital – the finance component of the alliance was missing. Indian commercial banks were not prepared to supply debt finance on competitive terms, and foreign Exim banks were only too happy to fill this gap. The fact that developers were able (and willing) to circumvent local content requirements was made possible by the poor design of this aspect of the process, and incentivised by these additional elements. This seems a significant missed opportunity, and has been recognised as such – the second phase of the NSM will remove the thin-film loophole, but also boost potential returns to attract Indian commercial institutions.

As we have seen, developments in the manufacturing sectors are strongly influenced by the pace and pattern of progress on installed domestic capacity. This is discussed below.

4.3 Case study category 3: investment to expand wind and solar generation capacity

In both India and China, solar energy generation on a significant scale is a recent phenomenon. Wind power, in contrast, has a longer and more complex history in both countries. Rather than divide these into different episodes, there is value in examining and contrasting the full period of wind installation for the two countries. As in the previous section, we are interested in the drivers of investment, particularly the role that alliances of different actors have played at crucial times. Following the analysis of wind power investment, the more recent sharp increase in investment in solar energy generating capacity in both countries will be examined.

4.3.1 A decade of wind power investment in India and China

Table 4.6 details the evolution of installed wind capacity in India (with a focus on Tamil Nadu) and in China from 2002 to 2007; Table 3.7 brings the story up to the present day. The first period of expansion is closely related to the development of manufacturing capacity over the same period, and many of the same trends can be seen. The approach to growing installed capacity in China is part of the same long-term strategy of increasing the proportion of wind in the energy mix, while building domestic manufacturing capacity to meet this demand. Similarly, the early period of installed capacity expansion in Tamil Nadu is largely the result of the refinement and scaling-up of the Suzlon turnkey captive power model. There is more to the story than this, however – particularly the motivations of some actors that have not yet been considered.

Tamil Nadu has the best wind resources in India. Along with other wind-rich states, such as Maharashtra (Suzlon’s home state) and Gujarat, Tamil Nadu hosted the expansion of the turnkey captive power model. Today, Tamil Nadu has the most installed wind capacity, but this was not the result of particularly high tariff rates in the early days. In 2002, Tamil Nadu fixed the wind power tariff at 2.70 rupees/unit, considerably below that available in the other two states mentioned.

Table 4.6 Evolution of wind generating capacity in China and India (Tamil Nadu), 2002–2007

Date	China	India
2002		The Tamil Nadu Electricity Regulatory Commission (TNERC) fixes a wind tariff of 2.70 rupees/unit. This is lower than in other states such as Maharashtra and Gujarat.
2003	NPC Standing Committee listed the Renewable Energy Law in its agenda of the year, and instructs its Environmental and Resources Protection Committee to organise the drafting.	Tamil Nadu Electricity Board (TNEB) runs (increasing) deficit. Facing strong competition from Bangladesh in textiles, wind power named eligible for concessional finance under the 'Textile Upgradation Fund Scheme'.
2004	Renewable Energy Law (Draft) submitted to NPC Standing Committee for approval.	Building on the example of Suzlon, textile firms and manufacturers in other sectors in Tamil Nadu increase investment in captive power model.
2005	NPC Standing Committee conducts second evaluation of the Renewable Energy Law (Draft), passing it in February. President Hu Jintao signs Presidential Decree No. 33 to enact.	Lack of connecting infrastructure from the wind-rich south to industrial north. No investment from TNEB in new corridors.
2006	Renewable Energy Law comes into force. NDRC issues 'Interim Measures on Renewable Generation Tariff and Cost Sharing Management', which sets national renewable surcharge on electricity prices. Renewable Energy Development Fund established.	Wind plants declared ineligible for 'Textile Upgradation Fund Scheme'. Grid infrastructure issues lead to task force creation between state government and Indian Wind Turbine Manufacturers Association. Tamil Nadu increases tariffs to 2.95 rupees/unit.
2007	State Electricity Regulatory Commission enacts 'Measures on Grid Company Obligated Full Amount Purchase of Renewable Generation', which requires grid companies to connect and purchase renewable energy. Target of 10% of energy from renewable sources by 2010, and 15% by 2020.	10th Plan period ends. Although record capacity addition seen in Tamil Nadu over Plan period, capacity addition then slows rapidly – similar slowdown in other wind-rich states such as Maharashtra.

Source: Adapted from Krishna *et al.* (2014, forthcoming) and Dong *et al.* (2014, forthcoming).

Despite high overall wind potential, there are few locations in India where yields are very high. Most high yielding sites (i.e. Classes I and II) are located in Tamil Nadu, and are thus highly valuable. In 2002, the Tamil Nadu Energy Development Agency (TEDA) conducted a survey to identify the most promising sites, which were largely located in the southern region. It was on these sites that many of the wind farms developed during the 10th Plan period were built. Under optimistic assumptions (e.g. capacity utilisation of 30 per cent, which was not uncommon in many of the better sites), the generation costs of wind power were approximately 1.2 rupees/kWh–1.5/kWh, compared to utility supplied power to industry at 4.5 rupees/kWh.¹¹ Based on these resources, the 2.70 rupee tariff announced by the Tamil Nadu Electricity Regulatory Commission (TNERC) looks attractive, particularly when combined with the tax benefits resulting from accelerated depreciation.

By the early 2000s, the textile sector in the state was facing strong competition from low-cost producers in Bangladesh, with major brands starting to relocate. Tamil Nadu was – and remains – the main centre of cotton production in India, and this prompted a strong reaction from mill owners in the state. Not least because of mill owners' lobbying efforts, the Ministry of Textiles had begun to supply concessional finance for technological upgrading in the

¹¹ The reasons for the very high cost of energy to industrial users have been explained previously in the report.

sector through the 'Textile Upgradation Fund Scheme' (TUFS). In 2005, 'captive' wind power schemes became eligible for financing from the TUFS.

It is easy to see why companies such as Suzlon and other wind investors would be in favour of such a move.¹² Why was the TNEB supportive of the TUFS, however, as well as the expansion of wind power more generally? The senior management of the TNEB had close relationships with the state government and, together, had worked on facilitating much of the investment in wind in the previous decade (1992–2003). This had also created good relationships with project developers (i.e. manufacturing firms). Between 2002 and 2006, a number of ratings agencies afforded Tamil Nadu the highest ranks marks in terms of 'attitude' and 'procedural issues' for wind power.

The TNEB had two interests: to increase the supply of power for industrial consumers; and to keep tariffs low for residential consumers, particularly in poorer areas. Between the late 1990s and 2007 most wind capacity addition was captive generation at sites already connected to the grid. For the TNEB, therefore, allowing captive generation enabled them to transfer surplus wind power to industrial users. Also, by charging for these wheeling and banking services, the TNEB earned significant revenues at minimal cost. Despite these additional revenues, the requirement to subsidise residential energy use meant that the TNEB continued to run (increasing) financial deficits.

The 'business model' relied on the transfer of power from the wind-rich south to the industrial north. By 2005, however, the capacity of the narrow corridor used to transfer power reached its limit. New farms added in the south could not 'wheel' power to the north. While the solution was to expand capacity, the fact that wind power is intermittent meant that for 65 per cent of the time the proposed new corridor would be unused, making it an expensive investment with low returns. Given its financial difficulties, no support for expansion from TNEB was forthcoming, though it continued to issue certificates for wind farms.

With elections looming, the state government did not take a view on the proposed infrastructure. In 2006, the incumbent party was defeated and the newly elected state government did not view the investment as crucial. Growth in projects stalled. The final nail in the coffin was the decision by the Ministry of Textiles that wind farms would no longer be eligible for the interest rate subsidy. The rationale was simple: firms investing in wind turbines were not making any upgrades to existing textile technology, which was the purpose of the TUFS. Despite representations by wind energy associations and a few investors from the textile sector, the decision was not revoked. The TUFS scheme itself lapsed in 2007. Although Tamil Nadu had seen a rapid expansion of installed wind capacity over the previous decade, by 2007 this had ground to a halt.

In comparison to this plethora of actors, the situation in China looks very straightforward. In 2007 the NDRC set a target of 10 per cent of energy from renewable sources by 2010, and 15 per cent by 2020, and enacted a law which obliged grid companies to connect wind facilities, and to purchase wind-generated power. The previous year, the Renewable Energy Law had been passed.

The goals of the Renewable Energy Law were to: 'promote the development and utilization of renewable energy, increase energy supply, improve energy mix, ensure energy security, protect the environment and achieve sustainable economic and social development' (National People's Congress 2005). The first draft was sent to over 100 institutions for

¹² There were three categories of investors: firms looking to hedge against electricity supply risk for their operations; those seeking tax credits; and those looking to diversify their sources of income away from power agreements with the state electricity board. Various production and wind farm associations were founded to further their common interests. Firms covered a variety of sectors: automotive manufacturers (such as Ashok Leyland); chemicals and cement; and, somewhat uniquely for Tamil Nadu, a large number of spinning mills and textile manufacturing entities. The Tamil Nadu Spinning Mills Association, for example, became one of the largest investors in wind energy during the period. These firms benefited significantly from the TUFS scheme.

comment, including State Council departments, different ministries, the People's Congress of Provinces, autonomous regions, municipalities directly under the State Council, as well as universities, research organisations, businesses and community groups. It was also put online, where suggestions from the public, including international organisations, were received.

In the formulation and review process, stakeholders showed unanimous support, with no opposition. This is extremely rare in China. As a result, the law only took a year and a half to develop.

Voting at the NPC Standing Committee also went smoothly. Normally, a law cannot be passed until its third evaluation, due to objections, yet the Renewable Energy Law was passed with a unanimous vote at its second evaluation. The whole process took less than two years, an unusually short time for legislation in China to be enacted.

Stakeholders showed unanimous support for two reasons. First, the scale of the renewable energy industry was too small at that time to threaten other stakeholders such as thermal power or grid companies. Second, there was no administrative institution for renewable energy at the time nor any vested interests involved. This lack of opposing forces was also a feature of the wind sector in Tamil Nadu, as well as in other 'wind-states'. By definition, the captive power model did not threaten the interests of existing power providers, as the energy was used largely by the developer. The fact that surplus power can be generated is also a positive, given India's energy shortfall.

While the enactment of the Renewable Energy Law in China gave a strong signal of continuing government support for renewable energy generation in general, and wind power in particular, progress with installed wind capacity had been slower than planned. China held four wind concession auctions between 2003 and 2006, with concessions awarded to the bidders offering to operate the concession on the lowest tariff. This led to fierce competition, such that the final price for the concessions made it difficult for investors to obtain a sufficient return. Consequently, installation and generation lagged behind schedule.

Following lobbying from the wind sector, and recognising the need for tariffs to be high enough to drive growth in capacity, the fifth concession tenders were organised differently, as described in Table 4.7. Rather than going to the lowest bidder, the fifth round saw concessions awarded to the bidder whose offer was closest to the average. This had a significant effect, with tariffs for wind generation in the new concessions rising to much more attractive levels. Building on this, the NDRC set four different tariff rates in 2009, based on relative wind resources in different parts of China. These were significantly above rates for coal power.

This period marks a rapid increase in wind energy investment in China. As illustrated in Figure 3.4, total investment rose from around US\$7bn in 2007 to US\$15bn in 2008, and to more than US\$25bn in 2009.

In India, there was recognition that the previous use of tax-based incentives had encouraged installation more than generation. By 2007 the turnkey model was being increasingly criticised by non-governmental organisations (NGOs) and others, who pointed out that a disproportionate number of facilities were erected just before the end of the financial year, and did not always begin generating energy once completed. The suspicion was that the primary motivation was to obtain tax breaks.

In a major shift, a number of measures were introduced at national level to incentivise wind power generation. First, in 2009 the Ministry of New and Renewable Energy (MNRE) introduced a small, 'generation-based incentive' (GBI) for wind energy. The rate was 0.5 rupees/kWh over and above power purchase agreements (PPAs). Although small, this was

important for ‘signalling’ reasons in that it demonstrated central government commitment to the wind sector, separate from the patchwork of incentives offered by different states. It also created incentives to increase the scale of wind farms. Second, the National Action Plan on Climate Change (NAPCC) introduced a ‘renewable purchase obligation’ (RPO) of 5 per cent on the states at the same time, with a requirement that this grew each year thereafter. A ‘renewable energy certificate’ (REC) market was also established the following year to enable resource-poor states to meet their RPO by buying surplus from resource-rich areas.

This combination of factors significantly increased the attractiveness of wind to international investors, who could benefit from these new incentives more than was possible with tax-based measures, which were of most use to Indian firms. In a break from the captive power model, this saw the development of the large-scale independent power producer (IPP) model (described in Section 2) which generated returns on equity of 20 per cent, above the ‘hurdle’ rate for international investors such as Goldman Sachs. In 2011, ReNew Power, Green Infra, and Mytrah all expanded their project portfolios, creating the largest annual wind energy investments in India.

Table 4.7 Evolution of wind generating capacity in China and India, 2007–2013

	China	India
2007–2008	Fifth wind concession tender for 700MW. Bidder with offer closest to the average value would win the tender. This results in rather attractive tariff (contrast to previous rounds).	
2009	NDRC sets differentiated feed-in-tariffs for four wind energy zones. The tariffs are significant premium over rates for coal.	MNRE announces ‘generation-based incentive’ (GBI) of 0.5 rupees/kWh over and above power purchase agreements (PPAs) worth US\$60m. NAPCC introduces ‘renewable purchase obligation’ (RPO) of 5%, which should grow each year.
2010	Renewable energy one of seven ‘Strategically Important Emerging Industries’ named by State Council. CDB provides US\$43.6bn to renewable energy manufacturing companies. Installed capacity of wind reaches 44.7GW, far beyond what the grid could then absorb.	CERC announces renewable energy certificate (REC). REC market opens.
2011	NEA issues ‘Notice on Enacting the Schedule of First Batch of Wind Farms for the “12th Five-Year Plan” Period’. No projects outside the list could be approved or receive subsidies. NEA regulates all aspects of wind sector, removing discretion of local government to approve facilities below 50MW.	ReNew Power, Green Infra, and Mytrah all expand project portfolios. Investment peak year for wind energy investments in India.
2012	NEA releases ‘Schedule of Second Batch of Wind Farms for the “12th Five-Year Plan” Period’, which approved projects with total capacity of 14.92GW.	GBI withdrawn, accelerated depreciation (AD) withdrawn, REC market failures. Dramatic fall in investments.

Source: Adapted from Krishna *et al.* (2014, forthcoming) and Dong *et al.* (2014, forthcoming).

As in China, a rapid increase in installed capacity resulted. In 2009, wind investment in India was a little under US\$2.5bn; by 2010 it was almost US\$6bn.

The reduction in global demand following the global financial crisis caused the Chinese government to reassess and prioritise areas it saw as key to long-term growth. This process culminated in 2010, when the State Council announced seven ‘Strategically Important Emerging Industries,’ which would be eligible to receive priority concessional finance from ‘policy banks’ such as the CDB. Renewable energy was named as one of the seven

industries. At the same time as the CDB provided US\$43.6bn to renewable energy manufacturing companies, installed capacity of wind in China grew enormously, reaching 44.7GW by 2011, far beyond what the grid could then absorb.

Why did installed capacity in China increase at such an unsustainable rate? The answer, once again, can be found in the activities of local government. As we have seen, local government officials are strongly incentivised to maximise local economic growth. Investment is a big part of this, and wind generation is particularly attractive. As with renewable energy generally, the greatest amount of total project investment in wind comes at the start. Investment in wind farms thus created a disproportionately large impact on a county/city's investment and growth performance. Local government officials, therefore, had a strong incentive to approve investment in wind power, and given the improved wind power tariffs, investors had good incentives to make these investments.

The final piece of the jigsaw was the project-approval rights of local government. Under the NDRC's 'Requirements on the Management of Wind Power Plants' of 2005, plants with capacity over 50MW were subject to NDRC approval. Provincial governments, however, had the right to approve plants with capacity below 50MW. This resulted in the '49.5MW phenomena', where developers focused on projects below 50MW or broke up large projects into several small ones.

These factors combined to rapidly increase investment in wind energy in an uncoordinated way. By 2011, installed wind capacity was 62.4GW, while grid-connected capacity was only 45.05GW.

Returns in the Indian wind sector had become sufficiently high by 2011 to attract international investors searching for high-yield projects. Concerns had also resurfaced that investors were developing projects to take advantage of the benefits of accelerated depreciation, then at 80 per cent. In this context, the government took two decisions. First, the generation-based incentive (GBI) was removed, as it was considered that feed-in-tariffs were already sufficient to produce an attractive return for investors. Second, appreciated depreciation was reduced to zero, to address concerns that investments were essentially tax-avoidance schemes. The impact on wind investment was dramatic, falling by a third in 2012, and by a similar proportion in 2013.

In 2011, the Chinese government responded to the excessive expansion of wind installation, driven by the forces described above. Taking strategic control over the expansion of wind capacity, the NEA issued the 'Notice on Enacting the Schedule of First Batch of Wind Farms for the "12th Five-Year Plan" Period'. This framework set out clearly the rate at which wind capacity should expand, and the proportions that would be approved by central and local governments, which were roughly half and half. No projects outside the list could be approved, and any that were built would not be eligible to receive public subsidies. The NEA also removed the local government discretion to approve facilities below 50MW, and regulated all aspects of wind industry. In 2012, the NEA released the 'Schedule of Second Batch of Wind Farms for the "12th Five-Year Plan" Period', which approved projects with additional capacity of 14.92GW.

Discussion of drivers and alliances

In the first period of expansion, we see the commercial alliance forged by Suzlon (and other manufacturers) supported by state agencies in Tamil Nadu, notably the TNEB. While the move into wind by these commercial actors was largely driven by other actions of these public agencies, which kept the price of power high and its reliability low, other state activities made the model viable. In this regard, the provision of wheeling and banking services, as well as a tariff rate that was attractive given high wind yields in the state, was crucial. When the limits of existing infrastructure were reached in Tamil Nadu, however, the returns to the TNEB of investing to expand capacity were less than the cost of expansion. At this point, the

interests of the different actors were no longer aligned and the expansion of installed wind capacity stopped. The model was not derailed by opposing forces, which were not present, but by the changing interests of a key member of the alliance that had supported it in the first place.

In China, we see the same actors as in the case of Goldwind. As we have seen, the aims were to develop competitive manufacturing firms and increase the proportion of wind in the energy mix. While both were achieved, the expansion of generating capacity was quite slow, largely as tariffs were insufficient to incentivise investment. The balance was not quite right between ensuring value for money for energy purchased, and providing incentives for developers. As described in Section 1, investment is the result of a business opportunity that is considered to be attractive. In renewable energy, the state often has to use 'policy rents' to create these opportunities. In the first period of wind power expansion in China, these appear to have been insufficient.

The second period of growth in wind generation in India marked a break with the first. Rather than developments driven by public and private alliances at state level, the key actor was national government. The introduction of national mechanisms, such as the generation-based incentive, coupled with generous feed-in-tariffs provided by states, created new business opportunities that required different groups of actors to exploit them. These alliances were broader than in the first stage of expansion, involving local and central government actors, commercial developers (IPPs), manufacturing companies, and investors – including international investors.

While this more closely resembles the broad-based support for wind in China, there is an important difference. Finance for development of the wind industry in China was provided by state-owned banks, which committed long-term funds at attractive rates. The IPP business model, in contrast, was largely funded by commercial domestic and international financial institutions, both of whom have very high return expectations. At least in part, China's banks supported wind, as it was a strategic priority to do so. Commercial institutions invested in the IPP model in India, as it produced more attractive returns than alternative investments. When the government reduced these returns by removing the GBI and accelerated depreciation, investment collapsed – the interests of a key player in the alliance were no longer aligned; more attractive returns could be obtained elsewhere.

The second period of generating capacity expansion in China was excessive. Here we can see interesting similarities with the overly rapid growth in solar manufacturing capacity. In both cases, we have an improved business opportunity, the arrival of new actors, and the absence of forces to constrain the ability of the alliance to achieve the goals of its 'members'. With solar, access to finance from excessively optimistic financial markets combined with the arrival of private equity investors wishing to 'get on the bandwagon'. With wind, the increase in tariffs to attractive levels combined with strong incentives for local governments to approve wind farms. In both cases, there was no coordinating agency. It is also interesting to note that competition between local government officials to maximise growth in their areas was an important contributory factor.

For wind generation, the excessive expansion was checked when the NEA assumed control over the whole wind sector, and removed the discretion of local government to approve smaller wind farms. In the next section we turn to solar generation, where the issue of overcapacity in the manufacturing sector in China is again a crucial driver.

4.3.2 A late burst of investment in solar power capacity in India and China

For most of the timeframe considered in this report, both India and China prioritised wind over solar energy generation. Despite vast resources, there was no interest in solar power in India until the mid-2000s. This began to change when the Ministry of New and Renewable

Energy (MNRE) developed plans for a National Solar Mission (NSM) from 2006. Unlike the situation with wind, therefore, the initial impetus to develop solar power capacity in India was a top-down, strategic decision. From the start, the intention was to leverage India's huge solar resources to both generate energy and develop a competitive manufacturing sector.

Table 4.8 Solar energy installation in China and India, 2006 to date

Date	China FiT	India NSM
2006		The MNRE begins to formulate a national mission for solar power.
2008	Overcapacity begins to be an issue in solar manufacturing sector. Geermu, a city in Qinghai province, begins signing contracts for PV plants (reaching 28 by 2011).	NAPCC announced, under the Prime Minister's Office. NSM moved from MNRE to NAPCC and launched. Initial budget allocation of US\$85m.
2009	Provincial FiT in Jiangsu province issued by Jiangsu provincial DRC (Development and Reform Commission). Qinghai creates strategy to develop PV industry through deployment. Constructions not started in the absence of any FiT.	NVFN becomes stakeholder in PPAs through National Thermal Power Corporation, a registered public-sector company.
2010	Provincial FiT in Shandong province issued by Shandong provincial DRC. Four PV plants in Ningxia Hui Autonomous Region approved with temporary FiT by NDRC, which was seen as a successful lobbying with NDRC by provincial government. CDB provides more than US\$40bn in support for renewable manufacturers (wind and solar), enabling a further increase in production capacity.	Asian Development Bank announces US\$400m commitment; 418 bids submitted for 1,000–2,000MW for phase 1. Project sizes are small (5MW cap). Thirty solar projects allocated, and the transparency of the process is lauded. Allocation of 172.3m rupees to 37 'solar cities'.
2011	In May, the governor of Qinghai lobbies the NDRC for national FiT. Then the scale of signed PV projects in Qinghai exceeded 800MW. The annual subsidy of 1bn yuan for solar generation became too much of a burden for Qinghai's revenue. In July, a unified FiT was issued by NDRC.	Financial closure achieved by 610MW of projects. Solar Energy Industry Advisory Council constituted by the MNRE to attract investments, encourage R&D and make the Indian solar industry competitive. Allocation of 350MW of solar projects under batch 2 (20 projects). 90% of projects in Rajasthan. Cap on project sizes relaxed (up to 20MW).
2012		Solar Energy Corporation of India (SECI) established under the supervision of the MNRE. PPAs directly signed with SECI.

Source: Adapted from Krishna *et al.* (2014, forthcoming) and Dong *et al.* (2014, forthcoming).

The situation in China was the complete opposite. China already had a competitive solar manufacturing sector. The problem was that it was too competitive; the rapid increase in investment from 2007 to 2008, driven by listings on overseas stock markets, led to a huge expansion in manufacturing capacity. This left China's manufacturers with large inventories and not enough buyers. Not for the first time, they turned to their provincial governments for help – the same governments that had been instrumental in supporting these firms and facilitating their rapid expansion. The solution was to expand domestic demand to absorb domestic supply, but this required supportive policies. From 2008, intensive lobbying began for the introduction of provincial feed-in-tariffs (FiTs) to incentivise the domestic deployment of solar cells.

As of 2007, therefore, when India launched the NSM, solar capacity was negligible in both countries.

Prompted by the prime minister's interventions at the G20, and also the actions of the vocal Minister of Environment and Forests at other international forums, a national climate agenda

had begun to take shape in India by 2006. When the National Action Plan on Climate Change (NAPCC) was launched, the solar mission that was being developed by the MNRE was placed under the aegis of the NAPCC. This provided a strong mandate and impetus for implementation of the policy.

Within the NAPCC, there was a view that the MNRE would not have the capacity to carry the mission forward, especially coordinating the other powerful stakeholders in the power sector. The Ministry of Power (MoP) thus became central to the process. Once the MoP was involved, its subsidiary bodies and public sector arms, the National Thermal Power Corporation (NTPC) and the Power Grid Corporation of India, also became closely engaged with the implementation of the solar mission. It is widely accepted in India that the launch of the NSM went very smoothly. As well as the MoP, the NTPC's role in standardising technical aspects of the mission is seen as having been crucial. Most importantly, a bundled power scheme for utilities (which reduced costs), technical screenings for the auction mechanism, and assistance in grid connection and management (which had plagued the wind sector), enabled the smooth implementation of the first phase.

As well as long-term offtake agreements at fixed tariffs, the payment structure of the NSM saw payments from state utilities to power producers routed through the Reserve Bank of India (RBI). As we have seen, many state utilities had long-term financing problems and were notorious for slow payment, or no payment at all in the worse cases. The involvement of the RBI gave investors some confidence that these issues would be avoided. The use of a 'reverse auction' to award concessions to developers willing to accept the lowest tariffs created strong downward pressure on prices.

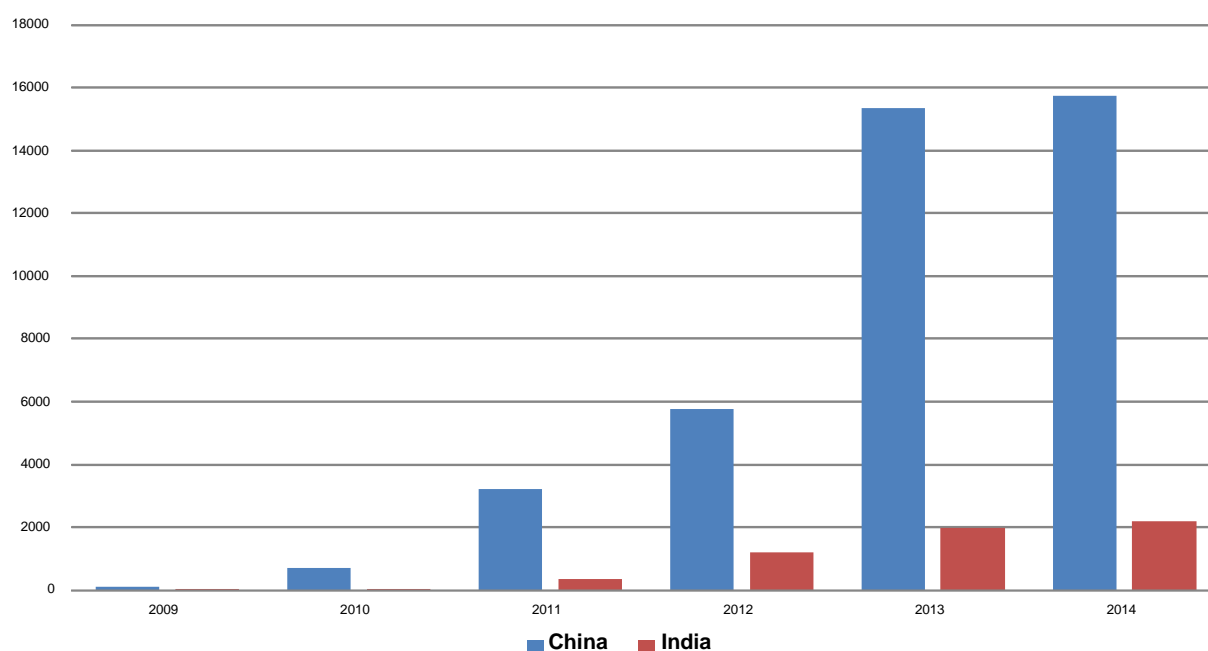
While implementation went smoothly, it was far from perfect. As described in previous sections, the attempt to develop local manufacturing went badly wrong, with developers circumventing local content requirements by using thin-film technologies. It is far from clear that this has left India with the most efficient form of solar power available. Second, the original cap on installation size (5MW) was also negative for generating efficiencies, though this was partly resolved in the second batch of auctions where the cap was raised from 5MW to 20MW.

Figure 4.1 shows the results of the NSM in terms of solar capacity. As we can see, from virtually nothing in 2009, total installed capacity reached 2,000MW by 2013, in line with the first-phase target.

While impressive, Figure 4.1 also highlights the far more rapid growth of China's solar capacity. Also starting from virtually nothing in 2009, installed capacity was more than 15,000MW by 2013. After years of no interest in solar energy at national level, the National Energy Administration (NEA) conducted the first concession tender for solar generation parks in 2009, a second in 2010 and a third in 2011. A national feed-in-tariff was enacted in 2011 by the NDRC.

As described above, local government – facing strong pressure from their provincial solar manufacturers – played a crucial role in the introduction of a feed-in tariff (FiT). In order to help local PV manufacturers, Jiangsu and Zhejiang province introduced provincial FiTs to increase demand and absorb surplus supply. In 2009, however, global demand recovered as a result of the introduction of post-crisis economic stimulus plans in many countries. Given the high profit margins available in international markets, China's PV industry was not very interested in developing solar plants domestically. As a result, the FiT policy did not really benefit the industry at this stage.

Figure 4.1 Cumulative solar power capacity in India and China (MW)



Source: Bloomberg New Energy Finance Database (BNEF 2014).

The stimulus-driven boost to global demand was only temporary, however, and was insufficient to counteract a further expansion in supply. As we have seen, the CDB lent more than US\$40bn to Chinese wind and solar manufacturers in 2010, driving a further expansion of supply. It was soon clear that global demand was insufficient to cope with this. In 2011, Qinghai approved many solar power plants in its jurisdiction and started to lobby the NDRC for a national FiT. By this stage, the scale of signed PV projects in Qinghai exceeded 800MW, and the cost of the provincial FiT had risen to 1bn yuan (US\$160m), far beyond what the province could afford.

In May 2011, Qinghai's party secretary and governor travelled to Beijing to meet the director of NDRC to lobby for a national FiT. According to 'Geermu City People's Government Meeting Minutes – PV Projects Symposia' dated 27 May 2011, the NDRC agreed to give Qinghai support for tariff policy, namely 1.15 yuan/kWh for all solar plants that had been constructed and connected to the grid by 30 September 2011 (Xie 2011). On 24 July 2011, the NDRC went further and formally issued its 'Notice on Improving Solar Feed-in-Tariff Policies'. As we can see from Figure 4.1, the results have been dramatic.

Discussion of drivers and alliances

By 2013, China had eight times the installed solar capacity of India. If the goal is solely to maximise the installed capacity of renewable energy, it would seem that China is by far the more successful. Things are not quite that straightforward, however. As we have seen, solar is a significantly less cost-effective form of renewable energy than wind. This is why China did not make solar a strategic priority as it did with wind. The rapid expansion of solar capacity was not a choice that the Chinese government made. Rather this was forced upon it by the need to support its manufacturing sector.

Again, unlike the situation with wind, expanding solar manufacturing was not originally a strategic priority, but was the result of an effective alliance of local government, SOEs and entrepreneurs, later 'unbalanced' by the arrival of international private equity investors. This situation changed after 2009 when renewables were listed as one of the '7 strategic industries' by central government, and the CDB was instructed to lend to these sectors. The huge investment that resulted, and the rapid expansion of manufacturing capacity that this

produced, exacerbated the supply glut and created the need to expand domestic demand to absorb this capacity.

Again, therefore, we have a situation of a relatively stable alliance becoming unbalanced by the arrival of a new actor. In this case, the first over-rapid expansion of manufacturing capacity was hugely exacerbated by the arrival of funding from state-owned banks now mandated to lend to manufacturers in solar. As with the period of excessive wind-capacity expansion, the situation was resolved by decisive central government action to balance global supply and demand conditions by sharply increasing China's domestic demand.

The India situation is almost the exact opposite. Unlike with wind, the decision to invest in solar was a top-down strategic move, ultimately driven by the prime minister's office. The NSM in India aimed to achieve a certain level of installed capacity and largely succeeded in signing contracts to fulfil that aim. Where the mission failed, however, was in its twin aim of developing local manufacturing capacity. The loophole left in the local content requirement was fully exploited by local developers, unable to access long-term debt in India but offered very attractive finance by the Exim banks of their competitors, notably China. As we have seen, the alliance forged by central government lacked an essential actor: a supplier of long-term 'patient finance'.

Again, this raises an interesting question. Indian banks are notorious for failing to supply long-term finance. This does not mean, however, that they were incorrect to conclude that the potential returns were not particularly attractive. A consequence of the 'reverse-auction' used in the NSM is that solar prices are driven down. While this may prevent solar costs becoming excessive, it does not necessarily provide an adequate return for investors. The comparison with China is again interesting. The first four wind concession auctions employed a similar – if less sophisticated – strategy, with concessions being awarded to the lowest bidder. It was only when a process that allowed more attractive pricing was introduced in the fifth round, however, that installed capacity rapidly accelerated.

In the final part of this case study section, we briefly assess more recent developments to see what light they shine on these issues and questions.

4.4 Some recent developments

March 2014 saw the first-ever default on a corporate bond by a Chinese firm. The firm was a solar power manufacturer. In some ways, too much should not be read into this event, as it signals a strategic shift on the part of the new Chinese premier to open the economy more to market forces. It is surely no coincidence that a solar manufacturing firm was chosen to be the first, however.

As we have seen, excessive capacity has long been a feature of the solar sector in China. This suggests that consolidation and an attempt to align supply with global demand is needed. There was another option though. China is large enough to be able to significantly affect both supply *and* demand conditions globally. We see this clearly in the wind sector. Following the exertion of central control by the NEA in 2011, China's manufacturing firms have thrived, despite challenging global conditions. It clearly helps that domestic capacity has continued to expand, and that this expansion is due to accelerate.

In 2014, China announced a plan to triple installed wind generating capacity by 2020. It is noteworthy that no such announcement has been made for the solar sector, where it would have been equally possible to expand domestic demand to absorb the global supply glut. Instead, a solar firm was allowed to default, suggesting that supply and demand will be balanced by reducing supply rather than increasing domestic demand.

The removal of the generation-based incentive (GBI) and accelerated depreciation (AD) in India led to a collapse of investment in wind. Unsurprisingly, this triggered a period of intensive lobbying by the Indian wind industry, which now included large international investors as part of a broad alliance. In 2013, the government reinstated both incentives and we have seen something of a recovery in investment. Structural financial difficulties remain a long-term problem at state level, however. A number of states have found it difficult to continue funding generous wind energy support schemes. In Gujarat in 2013, for example, a new wind farm was refused an offtake agreement, as the local electricity board decided that generous, cost-plus based APPC-based¹³ purchases would no longer be allowed. It seems clear that the APPC costs were too high for the financially constrained electricity board. Although ReNew Power lobbied hard to reverse this decision, this proved unsuccessful. A parallel series of petitions were also made to the state Chief Minister, who had, in the past, expressed his support for renewable energy in his state. Eventually, the electricity board and utility company compromised, agreeing that half of the capacity installed would be commissioned under an APPC-scheme and half would be commissioned under a cheaper, fixed tariff.

As we have seen, investments in wind in India were driven by attractive financial returns and an accommodating environment. These returns, however, are heavily dependent on state-level support through attractive tariff schemes, and – it transpires – central government mechanisms such as GBI and AD. When one or other of these is removed, the package appears fragile. The stability of this alliance going forward may therefore be questionable, as it appears dependent on the maintenance of financial support by actors who may be either unwilling or unable to perform this role.

In the solar sector in India, planning for the second phase of the NSM continues. This time round it is highly likely that loopholes in the local content requirements will be closed. Whether this drives a step-change in manufacturing capacity remains to be seen. It is also not clear whether this is any longer possible or desirable, given the situation with the Chinese manufacturing sector and the balance between global demand and supply. Whether this is the case or not, ensuring that finance is not supplied by the Exim banks of foreign competitors is an obvious precondition. Here, there appears to have been a recognition that phase 1 did not produce sufficiently attractive financial returns – and/or the returns expectations of commercial banks in India are excessive. A willingness to make government support more generous the next time round has been indicated, though it remains unclear what level of return will be required or the exact mechanisms that will be used to deliver this.

Having examined a number of cases in the Indian and Chinese wind and solar sectors, a number of very interesting features have emerged. In the final section of this study, we return to the questions that motivated this research, and ask what we have learned from these case studies.

¹³ APPC: Average Power Purchase Cost. Under APPC schemes, tariffs are based on the average production costs for energy.

5 Key findings

In the final section of this study we return to the research questions with which we began, and ask what has been learned from the case studies. The primary research question was:

What have been the primary drivers of investment in wind and solar energy in India and China?

In Section 1, the conceptual framework used to explore this question was outlined. As described, we are particularly interested in the role that ‘alliances’ of different actors have played in wind and solar energy investment in India and China, and the implications this has for policymakers concerned with accelerating these kinds of investment. Accordingly, four further research questions were identified:

1. Looking at important events and periods with respect to wind and solar energy investment, which actors were the most important in initiating and shaping these events?
2. What were the primary goals of these actors, and to what extent were they aligned?
3. To what extent, and in what ways, can these groups be described as alliances?
4. For those concerned with accelerating renewable energy investment, what lessons can be learned about the roles that alliances could play in this process?

Our case studies support the view that alliances matter. They do not explain everything, however, and their explanatory power varies by case. In some instances, alliances appeared to have played little or no role – an example would be Moser Baer Ltd’s attempt to become a globally competitive PV manufacturing firm. It should be noted, however, that the firm failed in this effort, suggesting that the lack of a supporting alliance may have been a problem. In other cases, we see strong evidence of the important role played by alliances, with these groupings taking different forms in terms of the actors involved, and the nature and duration of their involvement.

This section of the report considers what we have learned about research questions 1–3. In the light of these findings, we then turn in Section 6 to the final research question, and consider the lessons for different policymakers concerned with accelerating a transition to clean energy systems.

5.1 Actors and their motivations

In this section we describe the key actors involved in the different case studies, and consider the motivations for their actions – i.e. assess the first two research questions described above. The purpose is to enable an examination of the degree of alignment of their interests, and what this tells us about the nature and role of alliances (research question 3).

Table 5.1 summarises this information for the creation and expansion of wind and solar manufacturing capacity in India and China. For each sector, the role played by a particular category of actor in both countries is compared. The top half of the table deals with wind manufacturing. As we have seen, China’s central government was the key actor in the development of the sector. For motivation, the Chinese government’s goal was to develop internationally competitive firms, which would generate growth and employment. As they are evaluated on economic performance, local government officials in China have the same goals, creating a clear alignment of interests. Existing and emergent firms are concerned

Table 5.1 Key actors and incentives in creating and expanding manufacturing capacity

	Actor	Goals in India	Goals in China
Wind	Central government	Limited.	Develop internationally competitive manufacturers.
	Local government (including state agencies)	Politicians: ensure re-election; support local manufacturers. Electricity boards: increase energy supply, cross-subsidise residential users, and improve finances.	Promote investment and growth to enhance political promotion prospects.
	Existing manufacturers	Find solution to energy cost and reliability.	Diversify into new sector defined as 'strategically important'.
	Wind manufacturers	Expand market share and maximise returns.	Expand market share and maximise returns.
	Foreign donors	-	Support shift to renewable energy and exports of domestic firms.
	Foreign manufacturers	Increase exports and expand market share in huge potential market.	Increase exports and expand market share in huge potential market.
	Domestic financial institutions	Maintain links with existing clients (i.e. manufacturers) and maximise returns.	Support implementation of economic development strategy and achieve positive returns.
	International financial institutions and markets	Maximise returns (taking advantage of market conditions); avoid losses.	Maximise returns.
	Actor	Incentives in India	Incentives in China
Solar	Central government	Promote competitive domestic manufacturing sector.	Protect existing manufacturing firms from collapse, and safeguard employment.
	Local government (including state agencies)	Limited. Some interest in developing state capacity after NSM.	Boost economic growth; find economic 'niche' to compete with other provinces.
	Existing manufacturers	Diversify out of declining sectors.	-
	Solar manufacturers	Enter and gain market share in expanding global market based on low-cost production.	Expand and maximise market share in growing global market; subsequently, expand into growing domestic market.
	Foreign donors/governments	Incentivise PV installation in domestic economies; support exports of domestic PV firms.	Incentivise PV installation in domestic economies, and protect domestic manufacturers from Chinese competition (i.e. 'dumping').
	Foreign manufacturers	Increase market share in Indian market.	Reduce severity of competition from Chinese manufacturers.
	Domestic financial institutions	Maximise short-term returns.	Support implementation of economic development strategy and achieve positive returns. Promote exports – 2010 CDB support anomaly in this regard. Manufacturers allowed to fail to reduce oversupply in sector.
	International financial institutions and markets	Limited.	Maximise short-term returns by taking advantage of market conditions (e.g. 2005–7 spate of listings).

Source: Author's own.

with expanding their share of the wind turbine market, and maximising long-term profitability. Domestic financial institutions seek good returns and can lend profitably to successful firms. They were also mandated to support 'strategic' industries such as wind. For all the main domestic players in China, we therefore have a deep and durable alignment of interests in support of the creation of successful manufacturing firms.

The goals of foreign actors were more varied. Donors were concerned with supporting increased energy production in general (for development reasons), and renewable energy in particular (for environmental reasons). In some cases, they were also motivated to support the exports of their domestic manufacturers. This explains the support provided in the early stages of developing manufacturing capacity in China. These interests were aligned with those of manufacturing firms in donor countries, whose goals were to increase exports and gain market share in China's potentially huge domestic market. None of these actors were motivated to support the creation of an internationally competitive manufacturing sector in China. The alignment of interests with domestic actors was thus less deep and of shorter duration than that between the domestic actors themselves.

In India, central government played a very limited role and does not appear to have had a strategic objective to create competitive manufacturing firms in the wind sector. The main actors operated at state level, with existing manufacturing firms seeking an alternative to expensive and unreliable energy to boost their competitiveness. The development of the captive power model aligned with the goals of state electricity boards to boost the supply of energy and also provided revenues to reduce their financial losses. It also matched the goals of commercial banks to maximise returns with minimum risk, particularly as the end-to-end model saw developers take all project risks onto their balance sheets. Once the model had been successfully created by Suzlon, its goal was to expand as rapidly as possible, particularly as its debt-heavy model required continuing expansion to enable debts to be serviced. As suppliers of turbines for the expansion of Suzlon (at first) and other Indian developers, the goals of foreign manufacturers were also aligned.

Expansion of the market was ultimately constrained by state-level forces and the changing interests of key actors. Politicians' primary goal is re-election – and maintaining cheap electricity for residential users was important for this. This puts strong financial pressure on state electricity boards, however, preventing them from maintaining and upgrading infrastructure to allow expansion of the captive power model. Increasing infrastructure capacity in Tamil Nadu, for example, would have cost the electricity board more than the financial benefits they would gain. Realising the goal of improving their financial situation called for a different course of action, creating a misalignment with the goals of manufacturing firms.

When Suzlon took their model out of India, it was financed by both domestic and international investors, whose goal was to maximise returns. To generate these returns, Suzlon had to continue to grow rapidly, but this required an increasing market share and/or a rapidly growing global market. When neither of these occurred, we see a swift misalignment of interests between Suzlon and its investors, whose goals now switch from maximising returns to minimising losses. Again, we see a relatively shallow alignment of interests.

In solar, the Indian central government's goal was to develop domestic manufacturing capacity through the National Solar Mission (NSM). This matched the goals of nascent manufacturing firms, whose objective was to obtain a rising share of the domestic and global solar market. Unlike in China, however, where banks were mandated to support such strategic policy objectives, the goals of commercial banks in India were to maximise risk-adjusted returns in the relatively short term.

Returns from supporting NSM developers were not considered competitive compared with alternatives. Instead, we see an alignment with the goals of foreign Exim banks – and foreign

governments – whose interests were in supporting the exports of their own manufacturers. The goal of solar developers in India was to maximise returns, and the cheap finance made available from US and Chinese Exim banks was supportive of this. A loophole in the local content requirement made it possible for this alignment of the interests of solar developers and foreign financing institutions and manufacturers to be realised.

In the development of solar manufacturing capacity in China, local governments' incentives to maximise growth was again crucial. This aligned with the objectives of private firms wishing to expand into the global solar energy market. At the same time, governments in Europe were increasing their support for domestic PV installation, causing an expansion of global demand. While China's state financial institutions were not originally mandated to support solar manufacturers, international financial institutions saw the rapid growth in global demand – and buoyant market sentiment about Chinese manufacturing prowess – as an opportunity. Their goal was simply to maximise financial returns, and the listings of Chinese manufacturers in positive market conditions delivered precisely that. Local government officials obtained additional benefits from foreign listings in their performance evaluations, and so were strongly supportive.

After the global financial crisis, a goal of the Chinese central government was to find new sources of growth. Renewable energy was considered to be one such source, and was designated a 'strategic sector' in 2009. The resultant inflow of finance from state-owned banks enabled a second wave of expansion in manufacturing capacity, where the growth objectives of central and local governments and of commercial manufacturers became aligned. Most recently, central government appears to have recognised the oversupply problem that this broad alignment created and has begun to allow solar manufacturers to go bust, signalling a switch in objective from expansion to industry consolidation.

Table 5.2 applies the same approach to the creation and expansion of generating capacity in both countries. For wind in China, central government objective was to increase the supply of energy, with wind seen as one of the economically and technically viable means of doing so. This goal was fully integrated with that of developing competitive manufacturing firms – the growth of the domestic market would provide the basis for competitiveness to be created. Local government officials in China have the same primary growth objectives, as we know, and the 'front-loaded' nature of wind farm investments made them particularly attractive. The interests of these actors were again deeply aligned.

Wind farm developers' main objective was to maximise financial returns. Here an important difference with the first and second stage of Chinese wind power generation can be observed. In the first phase, the structure of the concession auctions led to quite low tariffs and insufficient returns for developers. In designing the auctions, the goal of the NDRC was to expand wind power at minimum cost, but this appears to have conflicted too much with developers' objectives, leading to a very slow rate of installation. From 2008, the NDRC changed its approach, now aiming to expand wind power at a cost sufficient to incentivise project developers. This increased the alignment of interests, and triggered a rapid expansion of installed capacity.

Given attractive returns and ready access to finance from Chinese banks, expansion grew more rapidly than could be absorbed by the grid. The key factor was the discretion of local government to approve smaller facilities, which allowed it to pursue its goal of maximising investment and growth in an unconstrained way. To support the objective of increasing the supply of energy (but in a managed and balanced way), central government established control over the sector, placing constraints on local government.

In the Indian wind generation sector, central government played a role from the start. Based on the goal of increasing energy supply and recognition of the benefits of wind and India's significant resources, wind power was encouraged through tax breaks such as accelerated

depreciation. In the first phase of growth, the other key actors were at state level. As with manufacturing, state electricity agencies had incentives to encourage the expansion of wind, as this increased the supply of energy in the state and generated revenues. However, they also faced constraints on their ability to do this, which led to a stalling of the captive power model. Before this limit was reached, developers profited from expansion in installed wind capacity, as did the financiers that funded them and the foreign (and domestic) manufacturers that supplied them with turbines.

Table 5.2 Key actors and incentives in creating and expanding generating capacity

	Actor	Incentives in India	Incentives in China
Wind	Central government	Increase energy supply at minimum cost.	Increase energy supply at minimum cost.
	Local government (including state agencies)	Politicians: ensure re-election (subsidised energy to electorate). Electricity boards: increase energy supply, cross-subsidise residential users, and improve finances.	Promote investment and growth to enhance political promotion prospects.
	Wind energy developers	a) Create and increase profits by expanding captive power model; b) create and increase profits by expanding IPP model.	Maximise returns by accessing state and central government incentives.
	Foreign donors and manufacturers	Encourage renewable energy generation, increase exports and gain market share in huge market.	Encourage renewable energy generation, increase exports and gain market share in huge market.
	Domestic financial institutions	Maximise returns and minimise risk.	Support implementation of economic development strategy and achieve positive returns.
	International financial institutions and markets	Maximise returns in internationally diversified portfolio.	Limited.
	Actor	Incentives in India	Incentives in China
Solar	Central government	Desire to establish international climate change ‘credentials’, and increase supply of solar energy at minimum cost.	Protect existing manufacturing firms from collapse, safeguard employment, and increase energy supply.
	Local government (including state agencies)	Limited.	Prevent local ‘protégé’ firms from collapse.
	Solar developers	Maximise returns.	Maximise returns.
	Foreign governments (and agencies such as Exim banks)	Incentivise PV installation in domestic economies; ensure incentives are affordable (and politically saleable); promote exports of manufacturers.	Incentivise PV installation in domestic economies; ensure incentives are affordable (and politically saleable); promote exports of manufacturers.
	Foreign manufacturers	Maximise market share.	Limited.
	Domestic financial institutions	Maximise short-term returns.	Support implementation of economic development strategy and achieve positive returns.
	International financial institutions and markets	Limited.	Limited.

Source: Author's own.

The role of central government in India increased in the second phase of expansion. The introduction of national mechanisms such as the generation-based incentive (GBI) augmented state-level incentives available for wind, boosting the profitability of wind farms. The GBI also encouraged larger-scale facilities; both the GBI and the development of larger facilities made wind in India attractive to a broader range of domestic and international investors. This resulted in the development of large wind farms selling energy to the power sector rather than to specific firms, as under the captive power model.

Installed capacity expanded rapidly until the government removed both GBI and accelerated depreciation. Returns from wind had risen to a level where these mechanisms were no longer deemed necessary to attract investors. From the government's perspective, therefore, this began to conflict with the goal of expanding energy use *at minimal cost*. The resultant collapse in investment suggests this was a miscalculation, and those mechanisms were indeed necessary to attract investment. The increase in investment following their reinstatement supports this view.

For solar power, central government was the key actor in both India and China, though for different reasons. In India, a strategic decision was taken to develop solar power through the National Solar Mission (NSM). As well as increasing energy supply and developing manufacturing capacity, the goals also seem to have included boosting India's 'credentials' with respect to climate change. Various central government bodies (e.g. key ministries, the Reserve Bank of India) were incentivised to support this strategic goal.

As described above, the main objective of solar park developers was to deliver their projects as profitably as possible. This aligned with the goal of foreign Exim banks to support domestic manufacturers in a context of excessive global capacity, and their willingness to supply low-cost finance. Commercial banks in India, in contrast, were simply concerned with maximising short-term returns. Financing solar through the NSM was not considered to be the best way of achieving this.

Part of the reason for this may relate to the central government goal of minimising the cost of solar. The design of the NSM reverse auctions was successful in achieving this, but it may have come at the cost of projects yielding insufficient returns to attract commercial investors. Here we can see some similarities with China's early approach to expanding wind generating capacity.

With solar, the Chinese central government's primary objective was not to expand generating capacity, but rather to support local government and prevent the collapse of large manufacturing firms, thus protecting employment. This strong alignment of national and local interests led to the implementation of the national feed-in-tariff and the rapid expansion of installed solar power capacity. Clearly, manufacturing firms' interests are strongly aligned with their own survival.

It is noteworthy that the fall in global demand that partly created the need for this move resulted from the reduction of government support for PV in key European markets. These governments' goals of expanding PV generation have become more difficult to maintain as fiscal positions have deteriorated. Again, therefore, we see the objective of expanding (renewable) energy production coming into conflict with affordability constraints. Unlike in wind, the Chinese government has not indicated a commitment to rapidly expanding solar power. Given differences in cost-competitiveness, this suggests that the affordability constraint is stronger for solar than for wind.

5.2 To what extent, and in what ways, can these groups be described as alliances?

While alliances cannot explain everything, they clearly have significant explanatory power. Even where we cannot observe them directly, this does not mean that different alliances are not at work.

The case studies examined in this research suggest three categories of alliance, which we can describe as: engineered, unbalanced, and uncoordinated. Each type of alliance can also differ according to three distinct but related dimensions: breadth, depth, and duration. Before concluding this study with a discussion of policy implications, the remainder of this section unpacks what we mean by these terms.

5.2.1 Engineered alliances

‘Engineered alliances’ are deliberately forged by an actor or group of actors to achieve a particular purpose. These actors may be state agencies (national or local) or commercial firms. It is also conceivable that such an alliance could be engineered by a civil society group.

In the case studies considered here, we can find a number of examples of alliances engineered by different actors to achieve different goals. In each case, the alliance was involved in the creation, enhancement or exploitation of a business opportunity. The development of wind manufacturing and generating capacity in China, for example, was made possible by an alliance largely engineered by central government, following a strategic decision to develop the sector. Here the business opportunity was created (i.e. the domestic wind market), enhanced (increased global demand for wind turbines), and exploited (by ensuring that manufacturing firms were in a position to take advantage of these opportunities).

The creation and growth of the solar manufacturing sector in China was facilitated by an alliance engineered by local government. Here an existing business opportunity (the global solar market, driven by developments in Europe) was exploited by the creation and support of firms able to successfully compete internationally.

The first phase of wind manufacturing and generation in India was also supported by an engineered alliance. This time, however, the ‘engineer’ was a commercial firm – Suzlon – which forged an alliance of public and private actors to solve a particular set of commercial problems. In this case, the ‘business opportunity’ was the result of very time- and place-specific factors and was exploited as Suzlon scaled-up its business model, tailoring it to the needs of local actors.

5.2.2 Unbalanced alliances

An ‘unbalanced alliance’ occurs when an engineered alliance changes, reducing its ability to achieve the original goals. Engineered alliances can become ‘unbalanced’ in one of two ways. First, new actors can join the alliance, hoping to get on the ‘bandwagon’. A good example from our case studies is the impact of international investors on the balance of the alliance supporting Chinese solar manufacturers between 2005 and 2007. Here we see uncoordinated expansion fuelled by the finance provided by overly ‘exuberant’ financial actors. Financial markets are prone to periods of boom (inevitably followed by bust). When international investors join an engineered alliance during a period of boom, the alliance may become unbalanced, leading to excessive expansion.

The second form of unbalanced alliance comes when an important member of an engineered alliance exits the group, or fails to join in the first place. In the former case, we can look at the constraints placed on the captive power wind model, when state electricity boards could no

longer support expansion. For the latter, the failure of the Indian government to bring domestic financial investors into the NSM alliance meant that the alliance was 'unbalanced' from the start. This prevented the achievement of one of the government's goals, i.e. the expansion of domestic manufacturing capacity.

5.2.3 Uncoordinated alliances

Uncoordinated alliances emerge spontaneously when a group of actors see their interests come into alignment under particular conditions. Such alliances are therefore dependent on the maintenance of this set of conditions. From our case studies, an example is the second phase of expansion of wind generation in India. While central government implemented national incentives, this was not a strategic effort to 'engineer' an outcome, as was the case with the NSM in solar – or wind in China. Rather, these mechanisms influenced the incentives facing a wide range of actors, and helped create the circumstances where a new business model emerged that met the goals of a new constellation of actors.

As shown by the impact of the removal of central government incentives, uncoordinated alliances are precarious. They are dependent on the maintenance of a particular set of circumstances and not supported consciously by powerful actors, as in the case of many engineered alliances.

5.2.4 Breadth, depth and duration

As shown in our case studies, alignment of interests in different alliances can be deep or shallow, short- or long-term. The development of China's wind industry, for example, was based on deep alignment of interests between key actors. In contrast, the more recent (uncoordinated) alliance supporting the expansion of wind in India is based on a relatively shallow alignment of interests. Broadly speaking, the deeper the alignment the more stable the alliance is in the face of changes in external conditions, and the more likely it is to endure over time.

This also relates to the 'breadth' of an alliance. The shallower the degree of alignment (i.e. the fewer the shared goals), then the easier it is for a range of actors to join an alliance – the broader it can be. The broader an alliance, however, the less likely it is to endure over time, as other goals will emerge (or existing goals change in importance) to change the incentives facing different actors.

Alliances that are deep (with many shared goals) and narrow (with relatively few key actors) are more likely to be durable over time. This does not mean they are 'better' than alliances between a wider range of actors who come together over a small number of goals. Different objectives will be best pursued by different types of alliances. Sometimes only a very broad alliance will do the job, and this will most likely be shallow rather than deep, lasting only as long as needed to achieve a particular objective. This does not mean it cannot be successful, however.

Finally, the success of all forms of alliance will be influenced by the strength of opposing forces. Both the captive power model in India and the passing of the Renewable Energy Law in China benefited significantly from the absence of opposing forces. This is likely to be the case at the early stages of development more generally, when the industry does not represent a threat to incumbent forces. For those concerned with ensuring the success of a new alliance, taking advantage of this window of opportunity to achieve the maximum possible (irreversible) progress would seem to be essential.

In the final section of this report, we consider the policy implications arising from this research.

6 Policy implications

This research is based on research into the drivers of wind and solar energy investment in India and China. We started from the position that the primary driver of investment is a perceived business opportunity and, in renewable energy, such opportunities often arise because governments provide incentives. This is what the literature tells us and it is confirmed by our case material. This explanation is not sufficient to explain the scale and pattern of investment that we observe, however.

Markets and governments do not operate in a vacuum but within specific political contexts. An emerging literature aims to cut through the complexities of these contexts by focusing on alignments of interests within public and private alliances. While the role of alliances in driving political change or economic reform has been explored, the perspective has not been applied to green investments. These often require support from governments to be attractive to investors, but also need investors to commit large sums with long payback periods. As a result, it is important that confidence exists that the 'package' that made the investment attractive will be maintained.

Our hunch was that effective alliances between the public and private sectors were important in this respect. If this is right, understanding how alliances form, and the conditions under which they succeed, may help to increase the level and pace of green investments. Fundamentally, therefore, this research has been motivated by the need to address the environmental challenges we face.

The focus on India and China should not suggest that these are the only countries that matter. Both historical responsibilities for climate change and the scale of current emissions demand that developed countries are at the forefront of such a transition. But progress has stalled in Europe and the US, politically and financially. Given this, perhaps it is now time to look elsewhere for solutions.

Understanding the drivers of green investments in the two countries is important for four reasons: first, how China and India meet their energy needs is crucial for growth and poverty reduction; second, their decisions will influence those made by other developing countries; third, what happens in India and China will also affect the options and incentives facing policymakers in developed countries; and fourth, taken together these direct and indirect effects may be pivotal in determining whether it proves possible to shift the world onto a sustainable development path.

The findings of this research, therefore, have significant policy implications for different types of policymaker, pursuing different objectives. There are two main goals that national policymakers might be concerned with in this regard: to increase the share of wind and solar energy in the national energy mix; and to create competitive manufacturing industries. The rest of this final section therefore considers the policy implications of this research for different national actors, before concluding with an assessment of the implications from a global perspective.

6.1 Large emerging-economy policymakers

Manufacturing firms need a large and growing market. While this can be global or domestic, the latter may be preferable as it provides a more stable foundation for long-term growth and competitiveness. Increasing domestic generating capacity through concessions with strong local content requirements is important for the development of a manufacturing base. As well as a large domestic market, this takes a broad-based alliance of actors bound by deep

alignments of interests. The state is most likely to have the tools and resources to create and maintain such an alliance.

But there are limits. The closer the alignments of interests, the less these need to be artificially maintained. When attempting to develop renewable industries, it is therefore advisable to focus on areas where the country has abundant resources that can be developed at reasonable cost. Renewable technologies that are most economically viable – given the country's resources and energy cost differentials – will require less artificial 'engineering', and will be more stable over time.

Alliances can become unbalanced when new actors join or important players leave. This means that 'engineers' need to maintain a clear overview of shifting interests, and maintain a balance. For example, the need to produce energy at as low a cost as possible has to be balanced with the need to provide sufficient returns for investors. To avoid the emergence of 'bandwagons', however, these returns should be sufficient but not excessive. Unconstrained access to cheap finance is a particular risk.

Finally, not all countries can have internationally successful manufacturing firms in low-carbon sectors. Where this is not possible, the focus should be on lowest-cost deployment, based on current and projected relative costs given the conditions that prevail in different countries.

6.2 Smaller developing-country policymakers

Realistically, smaller developing countries are unlikely to develop competitive manufacturing industries in large-scale renewable energy systems. Given this, the relevant policy questions are: which renewable technologies should be deployed and are there other low-carbon areas where competitive productive capacity could be developed?

For the first question, technologies where resources are abundant and costs lowest are again preferable. It may still be, however, that these are more costly than fossil-fuel alternatives and so require credible subsidies to be competitive. Given that low-income countries have limited resources and no responsibility for climate change, who should provide such subsidies? Here, we propose different forms of alliances, with donors providing finance for subsidies and working with developing country governments, local developers and financiers to ensure that energy is affordable. Again, it is important that the right balance is struck between driving down costs and providing sufficient returns for private investors, and that this balance is managed over time.

A priority of central governments in India and China has been to increase the supply of energy for national grids. Off-grid systems have not been prioritised, offering a potential niche for developing countries, where connecting rural communities may be more feasible (and economically viable) with off-grid systems. The experience gained in meeting the challenges this presents could be a route to creating competitive productive capacity. 'Engineering' alliances with donor agencies and technology companies from donor countries could potentially be fruitful.

6.3 Developed country policymakers

Given their higher cost base, it seems unlikely that developed countries will be able to compete in mass-produced renewable technologies over the longer term. Where these countries retain a major advantage, however, is in high-tech R&D and innovation. While increasing the scale of production has driven down the cost of wind and solar technologies, differentials remain. Fossil-fuel energy systems have been evolving for centuries, renewables for decades. The scope for innovation to reduce renewable energy costs is huge. Countries that achieve breakthroughs will gain first-mover advantage in new sectors.

There is scope for stronger low-carbon ‘innovation alliances’, with state agencies ‘engineering’ deep alignments of interest between private firms, financial institutions, and universities.

6.4 Global policymakers

This brings us to the global perspective. Seen from this vantage point, the only thing that matters is reducing the costs of renewable energy, increasing global supply and making it as easy as possible to shift away from fossil fuels, politically and technically.

Rather than competing fiercely for the same markets, a more specialised and complementary approach based on the comparative advantage of different countries may offer the best hope in this regard. Specialisation in terms of R&D, or manufacturing at scale, or designing technologies for off-grid use, offers private and public agencies in different countries the chance to pursue goals in a positive-sum way. Actors in global institutions or at national level with a global perspective should consider what tools are available to help them ‘engineer’ alliances to further these ends.

Finally, achieving a global deal on climate change would make this easier. The more progress is made on shifting to sustainable energy systems at national level, the stronger the aligned interests in support of accelerating this shift, and the weaker the national forces opposing this. This suggests that creating effective national alliances in favour of clean energy will ultimately make it easier to achieve a global deal on climate change, creating a positive feedback loop for increased investment.

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